A STUDY OF THE ABILITY OF PUBLIC SCHOOL STUDENTS TO VISUALIZE PARTICULAR PERSPECTIVES OF SELECTED SOLID FIGURES

By

WILLIAM PAUL PALOW

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To Mom and Dad

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KEY TO ABBREVIATIONS

Abbreviation	Definition
Corr.	Corrected Score
D. F.	Degrees of Freedom
I. D.	Identification Number
I. Q.	Intelligence Quotient
Ind. Var.	Independent Variable
Orig.	Original Score
SES	Socio-Economic Level
YY	Sums of Squares for Unadjusted Scores

CHAPTER I

THE PROBLEM

Introduction

To place in proper perspective the problem investigated in this study, the author has chosen to introduce certain necessary concepts of the theory in which it is embedded. The following are some preliminary ideas needed for an understanding of the problem.

Jean Piaget and his Geneva associates, especially Barbell Inhelder, have been rocking the educational world abroad, and finally in America, with Piaget's research derived theories of the cognitive development of the human person from infancy through adolescence. The latest of Piaget's many books to be published in the United States is The Child's Conception of Space (1967). Herein, Piaget goes to great lengths to distinguish between perceptual space and representational space.

Perceptual space is that awareness of the world which is received from the senses. It is much like the photographic reality of the Realist philosophical position. However, Piaget sees perceptual space as not only consisting of the data inputs from the senses, but also involving the experiences of motor activity carried on by the human organism. Hence, he prefers to think of perceptual space as a "sensorimotor space." Representational space, on the other hand, can be thought of as the ability to imagine the external world. Representational space arises after the child is able to symbolize objects and events through mental constructs or pictures.

Piaget sees representational space as evolving after and incorporating perceptual space. Perceptual space is depicted as developing through a series of three periods. The first period starts with the birth of the infant and continues through the age of four to five months. The period is " . . . marked by an absence of co-ordination between the various sensory spaces and in particular by lack of co-ordination between vision and grasping--visual and tactile-kinaesthetic space are not yet related to one another as a whole." (17:6) As the child progresses through this stage, he learns the following five elementary relationships between objects. The simplist of these relationships is that of proximity. Proximity describes the "perceptual structurization" of the nearness to each other of elements in the same perceptual field. The second relationship, separation, is the differentiations of one element from another so they do not blur together. Order or spatial succession is the third relationship. It " . . . is established when two neighboring, though seperate, elements are ranged one before the other." (17:7) The fourth relationship, enclosure or surrounding, is variously thought of as betweenness in the two-dimensional case or within in the three-dimensional case. A more complicated relationship is our fifth and last one, continuity. Continuity may be defined in the usual mathematical context in combination with the increasing ability of the child's senses to make finer readings as it were. Hence, the child is filling in his perceptual whole with these better data from the senses. All of these relationships Piaget classifies as topological.

The second period of perceptual growth is dominated by the ability to co-ordinate the various sensori-motor activities with vision. A good example is the ability to guide the hand to an object and grasp it using

vision. This co-ordination of sensori-motor action with vision depends on two underlying accomplishments. The first is the building up of figures as a result of objects being ascribed as of constant size during change of position. The second is the development of constancy of shape and size as a result of co-ordinating different views of the objective, i.e., perspective. (17:10) The former is Piaget's essence of Euclidean psychological space and the latter is his essence of Projective psychological space. We see, therefore, from Piaget's point of view that Euclidean and Projective spaces arise at about the same time in perception.

The third and final period of perception is enriched by systematic observation and inquiry, by tentative efforts at experimentation, and finally, by fully intelligent, practical activity through the internal co-ordination of relationships. (17:12) In the last part of this final period we see the appearance for the first time of images, symbols for objects or actions. Hence, the transition from perceptual to representational space has begun at about the age of 16-18 months.

Perception was defined as knowledge of objects resulting from direct contact with them while representation involves recalling objects in the absence of the object. Looking at the two definitions a little differently in perceptual space, the object signified and its symbolization are indistinguishable; on the other hand representational space is highly differentiated in that a very clear distinction is made by the child between the object (significant) and the symbol for the object (the signification).

Representational space has the task of repeating the accomplishments of perceptual space in the abilities to handle topological,

projective and Euclidean relationships. As a matter of fact, at the beginning of representational space, perceptual abilities are much more advanced than representational ones. It is not until the age of seven or eight years that the two spatial abilities come on a par with each other and the representational abilities begin to become more powerful than the perceptual abilities. The "common denominator" between the two spaces is that sensori-motor activity is at the base of both.

In the framework of representational space topological, projective, and Euclidean spaces have the following respective characteristics. Topological space is restricted to the object itself. The main function of this period is the structuring of the perceptual data into an organized whole. "The groupings involved in this process consist of additions and subdivisions of proximities and separations, the formation of ordered series, and enclosure by means of surrounding . . . " (17:245)

On the other hand, in projective space viewpoints are co-ordinated in terms of reciprocal relationships. As a result, the representations are not isolated mental pictures, but complete views taken from different positions. Like topological spatial relations, projective relations are qualitative; but unlike topological relations, projective relations deal with the object in relation to the observer rather than the object alone.

The final psychological mathematical space is called Euclidean space. The primary concern of Euclidean space is displacement and measure. In this particular space, we find the combining of the conceptions of distance and metric relations with a co-ordinate system. Some typical elements of Euclidean space are straight lines, angles, squares, circles, and so on. (17:vii)

As usual, Piaget formulates stages that children are observed to go through while their spatial concepts develop. These stages along with their substages are in order: I, IIA, IIB, IIIA, IIIB, and IV. These periods roughly correspond to the previously discussed stages of perceptual development. Stage II is related to the first perceptual period, stage III is related to the second perceptual period and stage IV is related to the third perceptual period.

Substage IIIB (age nine or ten) is crucial for what is to follow because it is here that projective ideas are fully understood, and it happens that it is also approximately the time at which Euclidean concepts develop. In a 1953 magazine article, Piaget states: "At the same time the child forms concepts of projective spaces he also constructs Euclidean space: the two kinds of construction are based upon one another." (15: 76) Piaget explains that the two conceptual abilities are very closely related and grow out of and upon the foundations of topological space.

"At the outset, simple topological notions enable the child to think solely of the object in itself unrelated to other objects save by way of relations such as serial enclosure or homeomorphic correspondence. But he soon finds himself compelled to venture further and link things together, either through an entire conceptual system of grouped displacements (measurements, distances, length, co-ordinates, etc.,) or else by linking them with different points of view co-ordinated globally (perspective projection and section)." (17:268)

However, while there is a simultaneous development, projective space seems to be the first of the two systems of abilities displayed by the child. Hence, we have the sequence topological, projective,

Euclidean which is at variance with the traditional sequence in which the topics are presented in the schools.

Statement of Problem

In examining whether a child had obtained Euclidean spatial abilities or not, Piaget devised an experiment in which the child was asked to visualize what the section of a solid figure would look like when a plane cut the appropriate figure parallel, perpendicular and oblique to its various axes. Success on this test is supposed to indicate the beginning of the ability to visualize in Euclidean space. Boe (1966) replicated this experiment on a group of children ranging in socio-economic class from upper-lower to upper-middle. (6:217)

Set up in this form, the problem is one of Euclidean space. But since projective and Euclidean spaces are so closely related, the problem may also be formulated in a projective manner with the same implications. In Piaget's words, " . . . although the experiment is kept within the bounds of everyday experiences, like seeing something cut with a knife, it is still the case that any pictorial, or even imaginary representations of it, nevertheless involve projecting the solid on a two-dimensional surface." (17:248)

The present study involved asking children to visualize two-dimensional perspectives of various solid figures after having been shown a photograph of the solid in three-dimensional space. Each real component of the solid figure was shown to the subjects before hand. This task is judged to be equivalent to, in a projective sense, asking the child to section a solid orthogonal to one of its various axes.

Specifically, the problem was to determine at what grade and age level the child manifests the beginnings of Euclidean spatial abilities as detected by this instrument.

Assumptions of Study

There were certain necessary assumptions to be made in this study. They centered around the instrument and were as follows:

(1) The instrument is valid.

(2) Each item in the instrument has an acceptable level of difficulty.

(3) Each item in the instrument has an acceptable level of discrimination.

(4) The instrument is reliable.

Purpose of Study

The purpose of this study was to determine whether children in the public school are able to visualize the perspectives of solid figures, and if so, when. Success on the instrument administered during this study is judged to indicate that the subject has reached (but not mastered) Piaget's third spatial stage. The abilities commensurate with Euclidean space are especially important because they involve "straight lines, angles, squares, circles, measurements, and the like . . . ". (17:vii) All of these topics are pertinent to the mathematics classroom at the secondary level.

Significance of Study

Although this study is closely related to the work of Piaget and Inhelder, it is not a replication of any of their experiments but a

logical extension of them. In particular, it has reference to Piaget's chapter VI, "Projective Lines and Perspectives"; Chapter VIII, "The Co-ordination of Perspective"; and Chapter IX, "Geometrical Sections," in The Child's Conception of Space. It encompasses abilities demonstrated in visualizing perspective, co-ordination of perspectives, and is the projective equivalent of the geometric sectioning experiment.

In the words of Piaget and Inhelder (1967), "The teaching of geometry could hardly fail to profit from keeping to the natural pattern of development of geometric thought, especially since this process is, to our way of thinking, in much closer conformity with the logic of mathematical construction than most of the so called 'elementary' textbooks." (17:vii) According to Flavell (1963) there are three possible educational uses of Piaget's work. Two of these are applicable here. " . . . it may be possible to make fruitful use of Piaget's research instruments in the assessment of the individual child's general intellectual development, special scholastic aptitudes, readiness for various kinds of instruction (e.g., number readiness), etc. - all with an eye towards practical educational matters such as grade placement and assignment to remedial training programs." (11:365) The second application involves the placement of curriculum content at appropriate levels. In both of these matters, an instrument to determine the presence of Euclidean abilities would be helpful.

Most of Piaget's critics and some of his admirers complain that he doesn't consistently report all of his data, in particular, the sizes of his experimental groups. Because of his style of research, he ignores factors other than age, although he admits that such independent variables as socio-economic background and intelligence might have an effect on the timing of his stages.

This study was designed to take account of these criticisms in that a large number of subjects were administered the instrument and the proper statistical analyses were applied to the data. This study is also significant in that it is comparing not only intelligence levels, but socio-economic levels as well. The scope of this cross-sectional study is also wider than any study reviewed in the literature in that it encompassed about one hundred children on each of the ten grade levels from the third through the twelfth grades.

CHAPTER II

A REVIEW OF THE LITERATURE

Theoretical Background

One of the foremost theorists in child psychology today is the Swiss born, Jean Piaget (August 9, 1896). Piaget has formulated a scheme in which the cognitive or intellectual part of the child develops through a sequence of stages which appear at about the same age in each child. Thus, at the age of nine or ten years, for example, the child learns how to measure, or imagine perspective by himself without the need for instruction. Before elaborating on Piaget's stages of intelligence, it is wise to explore a few concepts which are basic to his theory and research.

It is difficult to classify Piaget's theory as to the importance of the factors of maturation and experience. There are nearly as many views as there are commentators. Hunt sees Piaget's theory as both hereditarian and environmentalistic. (12:258) Almy describes four main factors which she thinks are incorporated into the system. These are maturation, experience, social transmission (association with other humans) and equilibration. (1:20) Baldwin can ascertain neither matural nor learning elements nor a mixture of the two in Piaget's theory. He sees equilibration, the basis of transition or growth, as a third kind of developmental process altogether. (3:289-290)

Equilibration is a sort of adaptive process based on the two reciprocal processes of assimilation and accommodation. Assimilation is characterized as a taking-in process. It is utilization of something from the environment. Psychologically, it is the ability of the human person to handle new situations and new problems with already existing mental organizations. Accommodation, on the other hand, is the complementary process of assimilation. Whereas assimilation is organism favored, accommodation is environment favored, in that the organism changes before it can assimilate phenomena from the environment. Psychologically, it is the change in organization which the human person makes to difficult situations which it cannot, at first, handle. When these processes are in balance, we have an equilibrium and, hence, the process of seeking this balance is called equilibration. Equilibration would go well with any interaction theory of an organism experiencing its environment.

Getting back to the stages of intellectual development postulated by Piaget, these stages are really different times at which Piaget sees the structure of the individual's mental facilities being fundamentally different. That is to say, there seems to be three periods in the development of the mental abilities of human beings such that the organization of these abilities is different enough to be clearly distinguishable. The preoperational period is a transitional one between the first two major organizations, sensori-motor operations and concrete operations. These organizations change through the process of equilibration and are built one upon the other. Each new stage incorporates what came before and adds something new at the same time.

The stages and a brief description follow: (main source is 16, pp. 120-128)

Sensori-Motor Stage

This stage is characteristic before the appearance of language and thus occurs from the ages zero to two years. It can be identified by the use and exercise of simple reflexes, the formation of first habits, and the beginning of coordination of means and goals. This stage is primarily one of exploration in which the child explores himself and the world from an egocentric point of view, i.e., the world and himself as one. While the child initiates the coordination of his perceptual spaces, he is still confined to a world of overt actions rather than thoughts. The end of this period is marked by object constancy and differentiation of self and world.

Pre-operational Stage

During the span from age two to seven years, the child shows manifestations of symbolic functions beginning with the appearance of delayed imitation (the ability to imitate an act after the example is no longer present). Now, the child is able to differentiate between objects and symbol for object, and it is no surprise that he acquires verbal signals and/or collective signals. Actions are still centered on the body and lack reversibility in that sense. The single most important feature of this period is the lack of conservation (the realization that there are invariants under certain transformations such as change of shape).

Stage of Concrete Operations

This stage lasting from seven to twelve years differs from the previous one by the mastery of reversibility and differs from the

following stage by the lack of ability to reason with propositions or hypotheses. As its name implies, this is the point at which the child may perform logical operations with actual, real, concrete objects to manipulate. He is also able to serialize (arrange in accordance to size or weight), to classify objects as to similarity or difference, and determine whether or not a certain object belongs to a particular group of objects. The concept of number and conservation are also understood at this point.

Stage of Formal Operations

The last of the steps in development ranges from twelve years and on through adult life. Its central feature is the ability to reason about propositions as well as objects. Not only is the child able to reason about the real but also the possible. The characteristics of the adult are clearly in appearance with such abilities as being able to group in flexible combinations each element of a system with any other element of the system. The operations of the mental structures are such that they obey all the properties of the psychological group much akin to the mathematical group.

As one might suspect, since the general intellectual abilities of the child develop through stages, specific abilities do also. Piaget and Inhelder's book, The Child's Conception of Space (1948, 1967), is an exposition of how the child psychologically develops the concept of geometrical space. It is a study of "certain problems of a general nature in regard to the development of spatial concepts in young children, dealing in particular with the elaboration of projective and Euclidean concepts out of more elementary topological notions." (17:vii) In a later book, The Child's Conception of Geometry (1960), Piaget, Inhelder

and Szeminska continue the exploration of spatial intuition with a discussion of measurement and metrical geometry. (18:vii)

As has been stated before, Piaget and his collaborators believe that the child's ability to represent space develops through the sequence of topological notions to a nearly concurrent development of firstly projective and then Euclidean notions. To obtain a better idea of how this progression moves, let us briefly examine the stages in the ability to coordinate perspectives.

The experiment was run by setting up a pasteboard model of three different colored mountains of varying sizes with a distinguishing characteristic on each mountain. A wooden doll was used to represent the positions from which the child was to visualize the mountains (the child always remained in the same position). Three methods were used to determine the child's ability to imagine the point of view of the doll. Firstly, the children were ". . . given three pieces of cardboard, shaped and colored the same as each of the mountains." (17:211) They were asked to arrange these pieces as the mountains would appear from the particular point of view. Secondly, they were asked to choose the appropriate photograph (from several others) for each point of view. Thirdly, they were asked to identify the appropriate position of the doll when shown a particular photograph.

> These experiments were carried out on one hundred children, 21 between 4 and 6; 6 years* 30 between 6; 7 and 8 years; 33 between 8 and 9; 6 years, and 16 between 9; 6 and 12 years. (17:212)

The results are summarized as follows:

---

* 6; 6 years - six years, six months

Stage I

Children of this stage do not understand the meaning of the experimental questions so they were not examined.

Stage II

> Throughout Stage II, the child distinguishes hardly or not at all between his own viewpoint and that of others represented by the doll in different positions. (17:212)

In Substage IIA, the view always turns out to be that of the child. At Substage IIB, some attempt at differentiation is made, but the child's point of view still prevails.

Stage III

> On the other hand (7-8 to 11-12 years), shows a progressive discrimination and coordination of perspectives. At Substage IIIA (averaging 7-8 to 9 years), certain relationships are varied with changes in the position of the observer, but there is still no comprehensive coordination of viewpoints. This is not achieved until Substage IIIB (about 9-10 years), at which point the mastery of simple perspective is complete and perspective has begun to appear in drawing. (17:213)

Stage IV

This stage is not mentioned because the ability has been developed by the end of Substage IIIB and, therefore, all children in this group should manifest coordination of perspectives.

Related Research

Piaget's research has been criticized severely and sometimes unfairly because there is misunderstanding of his methods of research. Piaget is unlike most developmental psychologists in that he had no formal training in the field. Almy reported in her book that Barbel

Inhelder has described him as a zoologist by vocation, and epistemologist by avocation, and a logician by method. (1:16) His starting point is, therefore, not the learner but knowldege and structure or logical organization of knowledge. (1:15)

In order to learn how the child structures his knowledge, Piaget has approached psychological studies with the methodology of the naturalist. As Hunt puts it, he has taken a notebook and followed the child around trying to discover the circumstances under which the child learns. (12:248)

Flavell is even more succinct when he points out that there are really two general types of research strategies in developmental psychology. The first is the antecedent-consequent strategy which attempts to isolate a developmental variable then find preceding or antecedent variables of which the first variable is a function. This is essentially the method used by most psychologists in the United States.

The second strategy is called developmental-descriptive and has its foremost model in the work of Piaget. "It takes as its major task to find out what behaviors develop with age (i.e., as a function of a complex of usually unknown events which unroll in ontogentic time) and also, there the strategist is so oriented, to seek out the sequential stages in this development. In contrast with the previous approach, individual differences in the developing consequent are not of primary interest, and no search is made for possible antecedents of these differences." (11:423)

Wallach (1963) wrote a summary of research over the period 1942-62 in which he featured the work of Piaget and his Geneva collaborators. The general outcome of the one hundred seven items in his bibliography is the following:

1) Although several people have replicated Piaget's various experiments and some shifts in age norms have been found as a function of socio-cultural status of the children, the general developmental sequences have, on the whole, been substantiated. (21:247) 2) Requisite training does not have an appreciable effect on the ability of children to perform ahead of their stage. What can be affected is only at the expense of extensive learning and may be effective only as the "given type or amount of experience is relative to the conceptual attainments already at the child's disposal." (21:251) 3) There is qualitative change in the structure of the child's thinking instead of a general development of the same type of thinking as in the adult. "The thinking of the ten-year-old, for instance, seems to involve different modes of analysis than that of the four-year-old." (21:267) 4) And lastly, "that the human's basic cognitive categories for analyzing physical reality are a product of slow and laborious construction." (21:271)

Almy (1966) gives a brief view of the studies reported in Flavell and updates the general literature in Piagetian research through 1965. She organized her review to answer questions concerning 1) the validity of Piaget's stages in other than Swiss populations, 2) the interrelation of abilities within the individual stages, 3) the relationship between other measures of mental ability and Piaget's examinations, and 4) the effect of experience on the process of progressing from one stage to the next.

In answering the first question, those studies reported seemed to confirm the notion that there is a general sequence of stages through which the child develops. Furthermore, this sequence is generally independent of the cultural origin of the particular individual. However,

these studies also indicate that the various stages are not necessarily tied to a strict chronological age. This result would not surprise Piaget in that he postulates on the basis of an average chronological age.

The second issue might be stated thusly. Does the individual child in a certain stage manifest all of the abilities which theory associates with that stage? The evidence in this area is conflicting and contradictory. It is still a very wide open question where much more research is required before a general conclusion can reached.

The third question really asks about the correlation of more generally accepted measures of intelligence to Piaget's measures of intelligence. Almy points out that, first of all, the two measures are based on very different definitions of intelligence, and secondly, Piaget's tasks test for concept ability, while more traditional tests measure certain psychometric notions of a specific character.

Because of the basis of his theory, Piaget has never denied the possibility of experience affecting the child's mental abilities. However, the overall conclusion which can be drawn from the studies reviewed by Almy is that the acquisition of the particular abilities such as conservation, may not, in general, be speeded up through instruction. This is not to say that children in a transitional stage may not be helped to acquire an ability of the next stage, but that children who do not, for example, manifest conservation abilities may not be taught to conserve. Even if the transition from stage to stage were susceptible to acceleration, there is a question of whether it ought to be accelerated because of possible harmful side effects to the cognitive structure of the child.

At least four writers have replicated some of the experiments from

The Child's Conception of Space. In alphabetical order, the most recent are Boe (1968), Dodwell (1963), Lovell (1959), Rivoire (1961). In her doctoral dissertation, Boe replicated Piaget's experiment on the ability to visualize geometric sections of solid figures before they were sectioned. She found that twelve-year-old children of more or less middle-class backgrounds still had not mastered the geometric sectioning task even though Piaget's theory predicted such mastery at age nine or ten years. She also found that there were no statistically significant interactions between age and ability to visualize sections as determined by her test, and that ability level as determined by the Lorge-Thorndike Intelligence Test did play an important role in the child's responses to the sectioning tasks. (5:418-420) However, her N was only seventy-two for the three grades eight, ten, and twelve.

In this introduction, Dodwell criticizes Piaget because Piaget "gives no indication of the numbers of children tested, of the consistency of trends from one stage to another with age, or--more important--the consistency of the steps in the progression within individual children." (9:141) Using an N of 194 from all socio-economic levels Dodwell replicated seven of Piaget's experiments in The Child's Conception of Space. From his sample of children ranging from five years and one month to eleven years and three months, Dodwell derived results which, while not totally, confirmed Piaget's hypothesis about the development of spatial concepts. However, he found it quite difficult to categorize any individual child into one of Piaget's substages. Each child seemed to have some of the appropriate abilities but not others. Dodwell suggests that the difference he found might be attributable to "special

interests and training, amount of formal instruction, and the difficulties of learning to apply a set of rules or operations learned in one context to new situations." (9:160)

Lovell is by far the most caustic of Piaget's critics reviewed. He criticizes Piaget's experiments because of lack of citation of exact numbers of children involved and because of lack of detailed information concerning the children's socio-economic background and their intelligence. He is also concerned about the exact nature of the apparatus used and the precise phrasing of the questions put to the children. But this is not all. Lovell also accuses Piaget of letting his background of zoology and recent interest in symbolic logic and the mathematics of groups and sets influence his model or the structure of the child's mind. (13:104)

Using an N of 150 children of age range two years eleven months to five years eight months from varying socio-economic background and general ability, Lovell replicated six experiments from the beginning chapters of The Child's Conception of Space.

Lovell finds points of disagreement in six out of the six experiments performed. He also finds partial agreement on some of the experiments but never full agreement.

"In conclusion, we can say that our evidence sometimes agrees with that of Piaget and Inhelder and sometimes is at variance. The variability in performance within age group is far greater than they allow." (13:116) He then attacks the basis of Piaget's theory, namely that the child's conception of space begins with topological concepts, and asserts that perhaps the child's world is not qualitatively different from that of the adult.

Rivoire (1961) devised a twenty-eight-item instrument by which she tried " . . . to determine whether the development of the concept of space in children evolves in the sequence hypothesized by Piaget." (20:47). Her "Form Development Test" consisted of seven items which were primarily projective, seven items which were primarily affine, and seven items which were primarily Euclidean in character.

She examined a sample of one hundred forty-four children ranging in ages from four years zero months to fourteen years eleven months. The subjects scored in the 90 to 110 category on the Stanford-Binet Intelligence scale, came from middle-class families of Tucson, Arizona, and were screened for variables such as, emotional problems, extreme reading problems, physical handicaps, etc.

She found a blurring and overlapping of Piaget's stages. The topological stage seemed to develop later than predicted. The projective and affine concepts appeared to introduce themselves earlier than expected and Euclidean concepts occurred later than hypothesized. (20:95) The following are her conclusions: 1) In general, the occurrence of the specific stages in the development of the concept of space hypothesized by Piaget is not completely supported by the results of this study; 2) The type of space being viewed is important; 3) Age is a significantly contributing factor in the development of the concept of space; 4) The individual item within the particular types of space being viewed is important in this development; 5) The development of perceptual processes utilized in seeing the visual world cannot be actually studies by utilization of isolated geometric figures; 6) Most children do not complete their space development by fifteen years of age

and 7) Four-year-old children do not, as a group, conceive of space entirely as characterized by topological relationships. (20:103-104)

As comprehensive as Rivoire's study is, this author cannot but wonder where conclusion number five came from. Rivoire conjures that the reason for the subjects performing better on one of the three dimensional items was that it was a total scene rather than a separated object. However, this is no justification for including the conjecture in the conclusions for there might be other explanations which are equally plausible.

Flavell reports six studies on the child's conception of space. Two of the six, Dodwell and Lovell, have already been reviewed above. The first of the other four articles is a report by Peel (1959) of two experiments involving Piaget's work on haptic or touch perception. Little was said in the original article about the first experiment except that it was run by E. I. Page " . . . on sixty children of about three to eight years of age . . .". (11:389) The results confirmed Piaget's hypothesis that topological abilities develop before Euclidean abilities. The second study was run on fifty-five children in the three to eight age range by E. Ferns. She administered the form of the haptic test which goes as follows. After the child has felt and explored objects outside of his vision, he is asked to draw them instead of matching them with visible objects as Page did above. The drawings were scored by Peel and Ferns essentially according to Piaget's stages and substages. A scalogram analysis showed that the developmental sequence outlined by the Geneva group was generally correct. (11:389)

Braine (1959) performed an experiment on spatial order or serialization using a nonverbal matching technique. He gave his subjects a

sample sequence of counters and asked them to match this sequence with one of three other sequences. Each correct response was rewarded with a piece of candy. His findings agreed with Piaget's in that his subjects were, for the most part, unable to match the longer sequences prior to the age of six or seven. "In particular, it was noted that not a single subject under four showed any semblance of an order concept, even with two-disc sequences." (11:389) A third study by Esteo (1956) was subjected to such convincing criticism by Flavell that it will not be recorded here. (11:383)

Meyer (1940) was a student and early co-worker of Piaget in his research on spatial representation. She subjected a group of children in the 1 1/2 to 5 1/2-age range to a battery of Piagetian-like tests not reported in The Child's Conception of Space. She found it possible to describe the growth of spatial abilities ". . . in terms of Piaget's concepts of 'practical', 'subjective', and 'objective' space, concepts originally applied to the earliest, sensory motor period." (11:390)

The following authors concerned themselves with the sequential of The Child's Conception of Space, The Child's Conception of Geometry. Their work will not be analyzed in detail but examined for evidence concerning Piaget's general theory of the development of space. Beilin and Franklin (1962) ran two experiments (N-27, and N-33) on two groups of middle-class children aged 6-0 to 7-3 and 8-1 to 9-4 with average I. Q. of 117.6 and 113.0, respectively. They were interested in whether a particular logical development results in the simultaneous ability to solve related problems, i.e., transfer of training and whether or not training has any effect upon age of acquisition of a certain stage or ability level as postulated by Piaget. In order to answer the above questions

they replicated Piaget's experiment with respect to the acquisition of measurement abilities. The results of the transfer of training experiment showed that, while transfer was not spontaneous but serial (occurred later), the sequence of events was as Piaget's theory predicted. Also, while instruction in the task (measurement) did facilitate acquisition of the operation, it was also found that the children in the first grade (stages I and IIA) were not able to achieve operational area measurement (stage IV) " . . . in spite of the training and measurement instruction." (4:618) However, it was shown " . . . that the Piaget testing situation itself acts to facilitate acquisition of operations . . ." and is, hence, a learning sequence in itself. (4:617)

Lunzer (1960) reports the findings of two studies. The first with an N of 24 is a replication of Piaget's experiment on conservation of volume. The results of the first experiment were a clear confirmation of Piaget's main findings in the development of conservation of volume. (14:196) The second experiment (N of 40 on children of age 12-13 years) was to test Piaget's assertion that conservation of displacement volume and the ability to calculate volume by multiplying three linear dimensions depends upon the notions of infinity and continuity. "The results do not support his contentions." (14:201) Lunzer argues that just because certain operations follow each other logically in mathematics does not mean that they should follow psychologically.

Of the four studies reported by Flavell in the section on geometry, two, Lunzer (1960), and Beilin and Franklin (1962), are reviewed above,

Lovell and Ogiloie (1961) gave Piaget's conservation-of-volume tests and variations of these to 191 British children in the age group seven to eleven years. Their results were the following: a) Conservation of

interior volume is displayed at a generally earlier age than conservation of occupied volume; b) some of the children incorrectly attributed the displacement of the water to the weight rather than the volume of the solid immersed; c) the means used to establish the age at which an understanding of occupied volume is reached varies from the 11-12 years age postulated by Piaget. (11:391)

Braine's 1959 report also contained an investigation which was conducted on the same group of children as his first nonverbal task. The subjects were first trained to determine the longer or shorter of two uprights where candy was again used as a positive reinforcement. Then using an upright which was compared to the first two, they were able to infer that if $A > B$ and $B > C$, then $A > C$ at an earlier age than predicted by Piaget. "Also, those children who were capable of transitive inference made more precise length comparisons in a purely perceptual situation - where no transitive inference was possible - than children who did not." (11:391) This, of course, is supporting evidence of the interaction of intellectual and perceptual spaces discussed in Chapter I. Also, upon making a logical analysis of the operations of spatial order and of transitive inference, Braine found them to be very much alike in contradiction to Lunzer, reported earlier. On the basis of this relationship, it was predicted that there was developmental interdependence between spatial development and the concept of transitivity. This prediction was born out when the two operations displayed almost identical growth curves and when children who were able to function with one were also able to function with the other.

Summary and Criticism

Although the various experimenters, more or less, agree with Piaget as to his stages and their sequence, they are not convinced of the absolute validity of his entire theory. While they 1) believe that he may have let his love of logic interfere with his thinking, 2) found varying ages for the stages, 3) found that experience may have an effect on the mastery of stages, and 4) that the testing situation itself may be a learning situation, only one (Lovell) finds it necessary to attack his basic theory as such.

Two interpretors of Piaget, Baldwin and Flavell, give us some good insights into Piaget's work as a whole. As to his methodology, Baldwin feels that Piaget's experiments have been badly controlled from the standpoint of experimental design and have been incompletely reported. (3:297) "Thus, despite the enormous amount of empirical data and the general confirmation of the findings whenever these experiments are repeated by other people, one is still left with the fact that all of these experiments must be repeated and confirmed by someone else before we can be confident about the children's range of responses to the experimental situations, before we can know how many children are exceptions to the generalizations, and before we can come to an unbiased view of the empirical evidence." (3:298) Even so, Baldwin relents a little when he asserts that if we look at Piaget's work as "exploratory and hypothesis-generating" then the above criticisms lose much of their punch. Furthermore, Baldwin asserts that Piaget's postulations are not yet a "rigorous theory of cognitive development." He goes on to state that he feels that Piaget became over enamored with mathematics and inappropriately tried to apply mathematical constructs which did not fit the data.

Flavell categorizes his "complaints" into three classes. These are the following: 1) matters of theory and interpretation; 2) matters of experimental design and data analysis; and 3) matters of the upward and downward relating of data to theory and interpretation." (11:427) In the first category, Flavell does indeed complain about the difficulty involved in reading Piaget. Piaget's definitions lap over from book to book and mean different things under different circumstances. It is contended that Piaget leaves "holes" in his reasoning from the empirical to the theoretical and that he leans toward over-theorizing. Flavell is generous in his second category when he makes it clear that Piaget should not be criticized because he did not answer questions which his research was not intended to answer, for example, the affect of socio-economic background of subjects. Also, that it would be unreasonable to expect Piaget to explore in detail an area into which he had "blazed a trail." On the other hand, Flavell insists that much of the criticism Piaget's experiments and theory have received is due to Piaget, himself. In his opinion, Piaget has not reported that "important minimum" which even exploratory work should make clear. Hence, colleagues speak of validation rather than extention. Piaget has failed . . . "to give a clear and full account of precisely what he did in the experiment." (11:430) Not enough information is given to allow the reader to make his own judgments as to what is to be concluded. Apparently, Piaget is not very vigorous in his sampling procedures. Even given the limitations of the "clinical method" the variations in procedure are too great. Lastly, Flavell complains that Piaget does not present even the most basic quantitative information. "As instances, he does not report the correlation between response level (stage) and age,

nor even the essential characteristics of the age distribution at each response level e.g., (means and standard deviations)." (11:432)

Finally, the third type of complaint concerning theoretical interpretation of empirical evidence follows from the first two sets of protests. Flavell sees Piaget as overinterpreting the evidence. He feels Piaget is "unparsimonious" in his interpretation and prone to " . . .multiplication and manipulation of entities beyond necessity." (11:433) Lastly, there is the tendency to make a statement without the necessary justifications and the appearance of forcing " . . . unwilling data into present theoretical molds. . . " (11:433)

Even with all these serious defects, Flavell is basically friendly toward Piaget's theory and thinks Piaget may be the foremost person in his field. As a matter of fact, Flavell emphasizes the contribution of Piaget's work and defends it against what he considers to be unfair criticism.

CHAPTER III

DESIGN AND PROCEDURE

Hypotheses

Since Piaget's theory indicates that Euclidean spatial abilities should start developing around the age of nine or ten years and be fully developed at age twelve, children from grades seven through twelve should manifest perspective abilities. Hence, the main hypothesis of this study is that all children in the age range associated with grades seven through twelve have the ability to visualize the two dimensional perspectives of selected solids while those in grades one through six do not.

The following are considered as subhypotheses because of their importance in the related literature. These hypotheses will be validated or rejected by testing the statistical or null hypotheses which immediately follow the subhypotheses.

Subhypotheses

a. The mean ability as indicated by the instrument will increase as the grade level increases.

b. The mean ability as indicated by the instrument will increase as the chronological age increases.

c. The mean ability as indicated by the instrument will be the same for the two sexes.

d. The mean ability as indicated by the instrument will increase as the socio-economic level increases.

e. The mean ability as indicated by the instrument will increase as the intellectual ability level increases.

f. The mean ability as indicated by the instrument will be affected by lower order interaction between grade level, sex group, and I. Q. level and/or by lower order interaction between age level, sex group and I. Q. level.

g. There will be more variability between the mean ability of grades three and six, than between the mean ability of grades seven and twelve as indicated by the instrument.

h. There will be more variability between the mean ability of ages eight and eleven than between the mean ability of ages twelve and eighteen as indicated by the instrument.

Statistical Hypotheses

1. There will be no statistically significant differences among the grade level means after adjusting for the covariates of sex, socio-economic level, I. Q. group, and age.

2. There will be no statistically significant differences between the means of the correct scores for the different grade levels.

3. There will be no statistically significant differences among the age levels after adjusting for the covariates of sex, socio-economic level, I. Q. group, and grade level.

4. There will be no statistically significant differences between the means of the correct scores for the different age groups.

5. There will be no statistically significant regression of the independent variable, sex.

6. There will be no statistically significant differences between the means of the correct scores for the two sexes.
7. There will be no statistically significant regression of the independent variable socio-economic level.
8. There will be no statistically significant differences between the means of the correct scores for the different socio-economic groups.
9. There will be no statistically significant regression of the independent variable intellectual ability level.
10. There will be no statistically significant difference between the means of the correct scores of the various ability levels.
11. There will be no statistically significant interaction between grade level and sex group.
12. There will be no statistically significant interaction between grade level and ability level.
13. There will be no statistically significant interaction between sex groups and ability levels.
14. There will be no statistically significant interaction between age groups and sex groups.
15. There will be no statistically significant interaction between age groups and ability levels.
16. There will be no statistically significant interaction between grade levels, sex groups, and ability levels.
17. There will be no statistically significant interaction between age groups, sex groups, and ability levels.
18. There will be more variability between grades seven and twelve than grades three and six.

19. There will be more variability between ages twelve and eighteen than between ages eight and eleven.

Design of Study

The general design of this study is that of survey research with the use of statistical methods for organizing the raw data. The data were collected by means of an instrument devised by this writer.

Approximately twelve hundred public school students in Duval County, Florida, have been administered the instrument. The sample population amounted to about one hundred twenty students from each grade level selected for this research. The students were tested in class groups to facilitate the collection of a large amount of data in a relatively short length of time and to minimize the amount of disruption to the operation of the classes themselves and to the schools in general.

Appropriate data were gathered from the cumulative folders of the respective students to answer questions as to the effect of any of the variables--age, grade, sex, socio-economic status, and intelligence (as indicated by an I. Q. score)--on a score obtained for this examination. The data obtained were treated with the statistical techniques listed under the section entitled Data Analysis Techniques. One hundred forty examination papers were rejected because there were insufficient data in the permanent records to determine intelligence scores or socio-economic level. The information most frequently missing was the intelligence measure, especially in the lower grades.

Pilot Studies

Both preliminary studies were conducted in P. K. Yonge Laboratory School at the University of Florida. The purpose of the first of these investigations was to determine which grades were to be tested in the main study. The criteria for elimination of a grade from the study was that 75 percent of the students were unable to successfully answer 50 percent of the items on the examination.

A sample of five children was chosen from each of the grades, one through four. Of the twenty children in the study, nine were boys and eleven were girls. For the most part, intelligence quotients were unavailable. Those available indicated the subjects were of average or above average in mental abilities. The teachers of those children with no record of mental ability measurement affirmed the reporter's suspicion that the remaining children were most likely in the above average category.

The subjects were tested individually in the play room at the laboratory school. The room was bare of all toys. The experimenter introduced himself and explained that they would be looking at some pictures and generally tried to make the youngsters feel more comfortable. The individual subject was shown each of the solids which had been photographed for the instrument. The solids were then put away except those which were used for the practice item. These were placed on the table between the experimenter and the subjects. An arrow and a small doll were then produced. The practice item was placed before the child and the possible choices were explained. The arrow was pointed at the proper side of the solid and the doll was placed behind the arrow. The

child was asked what the doll would see if she were looking at the object in the direction of the arrow. The subject was then asked to indicate his choice by pointing to the proper response on the practice item. The examiner then assured himself that the subject understood the task. Thereafter the solids, doll, and arrow of the practice item were put away.

The examiner placed each printed item before the subject and recorded the subject's oral responses on an answer sheet. The items were presented in four different randomized orders in cyclic fashion so that each particular randomization was presented to at least one child at each grade level.

The results may be seen in figure 1. Note that the means of the number of correct responses for grade one was 7.6, grade two was 10.0, grade three was 12.6, and grade four was 12.4. On the basis of these data and the criteria listed above grades one and two were eliminated from the large study.

The purpose of the second pilot study was to perfect mass testing procedures and to determine whether there was any learning effect caused by the sequence of the items on the test. To accomplish these aims, two tenth grade mathematics classes were chosen at P. K. Yonge. Each class of about thirty students was split into two approximately equal groups. One group was administered the instrument as it appears in Appendix A. The other was given one of the randomized sequences of items used in the first pilot study. This form of the test was accompanied by an appropriately numbered answer sheet. Both halves of each class were tested by the author at the same time.

The testing procedure was as follows. The examiner, who was introduced by the teacher, explained that they would be looking at a different

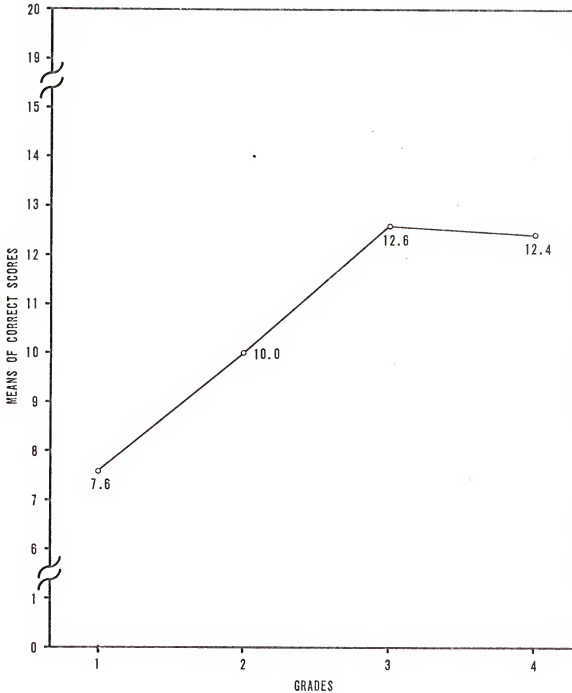


FIGURE 1
GRAPH OF MEANS OF CORRECT SCORES VS GRADES FOR FIRST PILOT STUDY (20 ITEMS)

type of "quiz." At this point the examiner stood at the center of the frontof the room and displayed each of the solids which were photographed singularly or in combination for the test. Because of previous difficulty encountered by persons reviewing the instrument, properties of the tetrahedron used for this study were especially pointed out and demonstrated. All solids except those for the practice item were put away. Test booklets, answer sheets, and instruction sheets were then distributed. The answer sheet was explained. The examiner had the subjects read silently the instruction sheet while he read it aloud. The practice item was demonstrated with the proper blocks and the arrow. Student questions were answered. Approximately twenty seconds were allowed for each item. Students were not permitted to advance to the next item in sequence until instructed to do so by the examiner. They were not permitted to review any previously attempted item.

The mean number of correct responses was computed for each type of sequence of test items. The resulting values for these means were 15.3929 and 15.2759. The two sets of scores were analyzed by means of a t-test to determine if there was a statistically significant difference between the above two values for the mean scores. No significant difference was found at the 1 percent level. Therefore, it was concluded that there was no appreciable learning effect caused by the sequence of items in the instrument as it appears in Appendix A.

Sampling Procedures

Because of the practicalities involved, it was planned to select one of the fifteen largest school systems in the state of Florida for the main study. The Duval County System was chosen because of convenience

as determined by physical proximity, willingness to cooperate, and availability of student personal data. With the aid of the director of the appropriate administrative level, four schools--two elementary, one junior high, and one senior high--were arbitrarily selected from a list of schools which were known to enroll students from a broad spectrum of socio-economic levels.

Approximately one hundred twenty students were tested from each of the grades three through twelve. Two elementary schools participated in the study because the population of the average elementary school in Duval County allowed for only three classes of youngsters at each grade level. Therefore, it was necessary to randomly choose two classes from each grade level at each of the two elementary schools.

At the junior high school level four classes of mathematics students were selected at each grade level. Almost every student at this school took math courses so this procedure provided a valid sample of students at each grade level. This particular junior high school was ability grouped so one slow group, two average, and one high ability group was examined in each grade.

The high school presented somewhat of a problem for sampling in that not everyone took mathematics. Therefore, it was decided to choose classes in which the largest number of students might be enrolled. Classes in American History, World History, and Psychology were judged to be best suited as representative of the student population because they were heterogenously grouped. A random sample of four classes or approximately one hundred twenty students was administered the instrument at each grade level.

Examination Procedures

The testing situation was structured in the following manner. The examiner was introduced to the class and he assured the examinees that their school marks would not be affected by the outcome of the test. The answer sheets and pencils were then distributed, and the answer sheet was explained with examples of possible responses. The examiner then displayed each solid which comprised all or a part of the figures which had been photographed as items for the instrument. The special properties of the tetrahedron of the test were given special emphasis. The solids were all put away except those needed for the practice item which was numbered with a zero. At this point, the examination, the instruction sheet, and the practice item were distributed. The instructions were read aloud to the examination group while they read along silently. The practice item was then demonstrated with the necessary solid components and indicator of direction. An answer was chosen for item zero, and it was seen that everyone understood the task.

Instructions were given to the effect that the examinees were to take the test at the same rate and that one may not go back and work on any item previously attempted. Approximately fifteen seconds were allowed for each item. Very few students found that this was insufficient time. The signal to proceed was given by calling out the number of the items on which the subjects were to be working. See appendices for examination and instruction sheet.

Coding Procedures

Before collecting student personal data, it was decided to code the data at the schools while reviewing the cumulative folders. The data were, therefore, coded according to the following conventions.

The grade was marked as it was listed in the cumulative folder. The age was registered to the nearest birthday. Sex was recorded as it appeared in the cumulative folder. The Otis Dudley Duncan scale was divided into three divisions and assigned the following numerals. The divisions were 0 through 40 - 1, 41 through 60 - 2, and 61 through 100 - 3. Intelligence scores were separated into three classes. Scores below 89 were assigned the numeral - 1. Scores between 90 and 110 were assigned the numeral - 2. Lastly, scores 111 and above were assigned the numeral - 3.

The Otis Dudley Duncan scale is a one hundred point " . . . socio-economic index for each of the occupations in the detailed classification of the 1950 Census of Population." (19:115) Information from the 1950 Census concerning the education and income of the various occupations were used to predict the rating obtained on the NORC - National Opinion Research Center - prestige scale for the respective occupations. (19:115)

The various general types of workers grouped together on the experimenter's adopted three-point scale is as follows. Service workers, farm laborers and foremen, operatives and kindred workers, craftsmen, foremen, and kindred workers constituted category one. Managers, officials, proprietors, clerical and kindred workers, and sales workers were classified in the number two category. The third category constituted professional, technical, and kindred workers. These are gross generalizations and, therefore, caused some overlapping of categories but is still a close approximation to the various groups. (19:155)

The classifications of the intelligence scores on the Kuhlmann-Anderson intelligence test is a modification of that shown in Table 6

of the Norms Manual for the seventh edition of the aforementioned test. (2:18) The modifications consisted of lumping together the classifications named "Dull" and "Mentally Retarded" into a group with scores less than 89 for the first category. The second category is comprised of those scores between 90 and 110 and constitutes the Kuhlmann-Anderson "average group." The last modification of the Kuhlmann-Anderson classification consisted of changing the upper limit of the "average group" classification from 109 to 110. The "Superior" and "Very Superior" classifications with scores above 111 made up the third category used by this writer. The reason for using just three categories was to get as many subjects as possible into each group and thus avoid empty cells in the statistical procedures.

Data Analyses Techniques

The data were treated with three statistical methods. A four-way analysis of variance utilizing a general linear hypothesis computer program which allows up to twenty empty cells was run on the variables of sex, ability level, age group and socio-economic level. A second four-way analysis of variance was run on the variables of sex, socio-economic level, ability level, and grade level. (See Chapter V) It was originally planned to use a five-way analysis of variance. However, the inclusion of both grade level and age would make it theoretically possible to have 18-year olds in the third grade. This type of possibility would lead to a number of empty cells which was well beyond the limits of the presently available program for analysis of variance. The information lost by running the two four-way analysis instead of the five-way analysis was interaction effects between grade and age and fifth-order interaction effects among the variables.

The statistical technique analysis of covariance was used twice. The first analysis stripped out the effects of sex, ability level, socio-economic background and age level. This adjusted score was plotted against the independent variable of grade (See Chapter V). The second analysis stripped out the effects of sex, ability level, socio-economic background and grade. The resulting adjusted score was plotted against age. (See Chapter V).

The last statistical techniques were used to examine the instrument. An item analysis was carried out to determine the level of difficulty and degree of discrimination of the test items. A reliability coefficient was computed using the split halves method and the Spearman-Brown Prophecy formula.

CHAPTER IV

THE INSTRUMENT

Introduction

The instrument (see Appendix A) consisted of a twenty-page, twenty-item paper and pencil examination with a practice item comprising a whole page inserted before the main test. An instruction page preceded the practice item. Each page of the test contained only one item. Each item consisted of a photograph of an arrow pointed at a solid figure positioned at the top of the sheet of paper.

The function of the instrument was to obtain a measure of the ability of children to visualize two-dimensional perspectives of solid figures. More generally, the purpose of the research was to determine at what age or grade children were able to obtain a maximum correct score with this instrument, which would be indicative of the above ability. The ability to visualize perspectives of solid figures has been established as an Euclidean spatial task and, therefore, indicates the beginnings of Piaget's Euclidean spatial period. The instrument detects this period.

The arrow in the primary photograph of each item indicated the direction from which the subject was to visualize each solid. Below the photograph on each page were four smaller photographs, each of which pictured a different two-dimensional perspective of the solid. Each of these smaller photographs represented a possible response and, together

with a fifth choice: "None of these views is seen from the position of the arrow," comprised the total of the possible answers for a particular item. Upon being asked " . . . to imagine what the block would look like if you were directly behind the arrow looking at the block," the subjects chose from one of the possible five responses.

In every case, one of the four smaller photographs was an actual photograph of the solid in question from the proper point of view. A fifth choice was included to discourage a forced guess. Correct answers were assigned positions on each of the items by random numbers. The subjects were given sufficient time to consider and attempt every item.

In Chapter I, four assumptions were made about the instrument administered in this research. The first assumption concerned the validity of the instrument and will be argued in the section entitled "Validity." Assumptions two and three which were related to item difficulty and discrimination respectively, will be discussed within the section entitled "Item Analysis." And the fourth assumption, which pertained to reliability, will be examined within the section called "Reliability."

Validity

The question of concern was whether or not the instrument used in this research was valid for measuring the ability of children to visualize two-dimensional perspectives of solid figures? There are two types of the several kinds of validity which seem to be appropriate to answering this question with the characteristics of this reseach. These two types of validity are content validity and face validity.

Content Validity

The first step in judging constructor validity as defined by Davis (8:32-34) is to define the ability to be measured. As stated before, it was desired to determine whether or not children were able to visualize two-dimensional perspectives of solid figures after viewing the solid from a three-dimensional perspective.

Step number two involves examining each item to determine what skills or abilities were necessary to give a correct answer. The twenty items of the original instrument were separated into seven categories. The seven categories and the appropriate item numbers are as follows:

1) Those items depicting single solid figures having no general name: 1, 6, 15, 16;

2) Those items depicting a cylinder, either alone or in combinations with another solid: 2, 7, 13, 14;

3) Those items depicting a cone, either alone or in combination with other solids: 3, 12;

4) Those items depicting a tetrahedron, either alone or in combination with other solids: 4, 20;

5) Those items depicting a large rectangular-shaped solid in combination with either a rectangular-shaped solid, a square-sahped solid, or a triangular-shaped solid: 8, 9, 10, 17;

6) Those items depicting a pyramid, either alone or in combination with another solid: 11, 19; and

7) Those items depicting a sphere in combination with another solid or a hemisphere alone: 5, 18.

It is appropriate here to comment on the practice item. The practice item pictured the 3" X 4" X 1" rectangular solid standing on its shorter end with an oval-shaped 1" thick solid mounted on top. The arrow was pointed orthogonally toward the 4" X 3" surface of the rectangular solid. The ability necessary to choose a correct answer was to

imagine what the combination of solids would look like from the direction of the arrow. Specifically, this involved realizing the solids would appear as a rectangle with an oval in the center of the top side. The correct response was number 4.

The first of the items in category one (item 1) pictured a 1" X 1" X 3" rectangular solid with an arrow pointing orthogonally at the right hand square-shaped end. The ability necessary to choose the correct answer for this item was the ability to place oneself behind the arrow and to imagine what the square-shaped end would look like. Specifically, this meant realizing that the indicated view was a square. The answer was a photograph of the appropriate end of the solid depicted in choice number 3.

The second item in category number one (item 6) pictured a 3" X 4" X 5" X 1" triangular prism with an arrow pointing orthogonally at the triangular-shaped face nearest the viewer. The ability necessary to choose the correct answer for this item was to place oneself behind the arrow and imagine how the solid would appear from that view. Specifically, this meant realizing that the longer of the 3" and 4" sides was on the left side of the figure from the appropriate view. The correct response was number 4.

The third item in category number one (item 15) pictured a 5" X 2" X 3" X 1" X 1" trapezoidal-shaped solid with an arrow pointed at the 3" side of the trapezoid orthogonal to the altitude of the trapezoid. The ability necessary to choose the correct answer was to imagine how the solid would look from the direction of the arrow. Specifically, this entailed realizing that the indicated view resembled a rectangle. The correct response was number 4.

The fourth item in the first category (item 16) pictured a 2" X 3" X 4" X 2" right triangular solid with an arrow pointed orthogonally at the triangular-shaped right-hand side of the solid. The ability necessary to choose the correct answer was to visualize how the solid would appear from the direction of the arrow. Specifically, this called for realizing that the indicated view was that of a right triangle with the hypotenuse on the left-hand side. The correct response was number 1.

The first item in category number two (item 2) pictured a cylinder with a diameter of 1 3/4" and an altitude of 2" with an arrow pointed orthogonally at one of the bases as the cylinder lies on its side. The ability necessary to choose the correct answer was to imagine how the solid would appear from the direction of the arrow. Specifically, this called for the realization that the base of the cylinder would appear to be a circle. The correct response was number 4.

The second item of category number two (item 7) pictured a cylinder with a diameter of 1 3/4" and an altitude of 1/2" with an arrow pointed orthogonally to the lateral axis of the cylinder. The ability necessary to choose the correct answer was to visualize what the solid would look like from the direction of the arrow. In particular, this would involve realizing that the cylinder would appear as a horizontal rectangle from the indicated view. The correct response was number 4.

The third item of category number two (item 13) pictured a 3" X 5" X 1" rectangular solid with the larger cylinder positioned toward the rear of the block with the arrow pointed orthogonally at the longer side of the rectangular solid. The ability necessary to choose the correct answer was to imagine how the solid figure would appear when viewed from

the direction of the arrow. Specifically, this involved realizing that the cylinder appeared to be on the right-hand side when viewed from the indicated direction. The correct response was number 4.

The fourth item of category number two (item 14) pictured the large cylinder and a hemisphere of 1 3/4" diameter on top of the cylinder. The arrow was pointed orthogonally to the lateral axes of both cylinder and hemisphere. The ability needed to choose the correct answer was to visualize the solid figure from the direction of the arrow. In particular, this involved realizing that the solid figure would appear as a rectangle with a half circle on top. The correct response was number 1.

The first item of the third category (item 3) pictured a cone with a base diameter of 1 3/4" and an altitude of 2". The arrow was pointed orthogonal to the altitude of the cone. The ability needed to choose the correct response was to imagine what the cone would look like from the direction of the arrow. In particular, this involved realizing that the cone would appear as a triangle with a slightly round apex and base. The correct response was number 4.

The second item of the third category (item 12) pictured the above cone on a 2" X 2" X 1" base. The arrow pointed orthogonally in the direction of the altitude of the cone. The ability needed to choose the correct response was the ability to imagine what the solid figure would look like from the view indicated by the arrow. Specifically, this involved realizing that the cone and square-shaped solid would appear as a triangle mounted on a rectangle. The correct response was number 2.

The first item of the fourth category (item 4) pictured a tetrahedron with two of the sides perpendicular. The arrow was pointed at one of the sloping sides of the tetrahedron and parallel to its base.

The ability needed to choose the correct answer was the ability to imagine how the tetrahedron would look from the direction of the arrow. Specifically, this involved realizing that from the direction of the arrow the solid appeared as a right triangle with the longer leg on the left-hand side. The correct response was number 1.

The second item in the fourth category (item 20) pictured the preceding tetrahedron mounted on a 2" X 2" X 3" X 1" triangular base. The arrow pointed at one of the sloping faces of the tetrahedron parallel to the base of the tetrahedron. The ability necessary for choosing the correct answer was the ability to imagine what the solid figure would look like from the direction of the arrow. Specifically, this involved realizing how the solid would appear as a right triangle mounted on a rectangle with the right angle of the triangle on the right-hand side. The correct response was number 4.

The first item of the fifth group (item 8) pictured a 2" X 4" X 1" rectangular solid with the 1" X 1" X 3" solid from the first item of the first group mounted on top and to the rear of the rectangle. The arrow pointed orthogonally at the long side of the rectangle. The ability necessary for choosing the correct answer was the ability to imagine what the solid figure would look like from the direction of the arrow. In particular, this involved realizing that the solid would look like a rectangle with another smaller rectangle mounted on top. The correct response was number 2.

The second item of the fifth group (item 9) pictures the 3" X 4" X 1" rectangular solid with a 2" X 2" X 1" solid mounted on top and to the back left of the larger rectangle. The arrow pointed orthogonally toward the longer side of the rectangle. The ability necessary for choosing

the correct answer was the ability to imagine what the solid would look like from the direction of the arrow. Specifically, this involved realizing that the solid would appear to be a long rectangle with a shorter one on top and to the right-hand side. The correct response was number 3.

The third item of the fifth group (item 10) pictured the 3" X 4" X 1" rectangular solid with the 2" X 2" X 1" rectangular solid placed in the center of the top surface of the larger rectangular solid. The arrow was pointed orthogonally toward the longer side of the rectangular solid. The ability necessary for choosing the correct answer was the ability to imagine what the solid figure would look like from the direction of the arrow. Specifically, this involved realizing that the solid would appear to be a long rectangle with a shorter rectangle on top and in the center of the first. The correct response was number 3.

The fourth item in the fifth group (item 17) pictured the 3" X 4" X 1" rectangular solid with a right triangular prism measuring 3" thick having an altitude of 2" mounted on top and to the rear of the rectangular solid. The arrow pointed orthogonally toward the longer side of the rectangular solid and orthogonally toward the triangular surface of the top solid. The ability necessary for choosing the correct answer was the ability to imagine what the solid figure would look like from the direction of the arrow. Specifically, this involved realizing that the right angle of the triangular-shaped solid was toward the center of the rectangular-shaped block, and the triangular-shaped solid would appear on the right side of the rectangular-shaped solid when viewed from the long side of the rectangular-shaped solid. The correct response was number 4.

The first item of the sixth group (item 11) pictured a regular pyramid with a 2" X 2" base and a 2" altitude. The arrow was pointed orthogonally toward the altitude of the pyramid. The ability necessary to choose the correct answer was the ability to visualize the appearance of the solid from the position of the arrow. Specifically, this entailed realizing that the solid would look like a triangle with base down from the indicated view. The correct response was number 3.

The second item of the sixth group (item 19) pictured the regular pyramid from the item one of this group mounted on a 2" X 2" X 1" base. The arrow was again pointed at the altitude of the pyramid. The ability necessary to choose the correct answer was the ability to visualize the solid from the direction of the arrow. Specifically, this involved realizing that the solid would appear as a triangle on top of a rectangle from the indicated view. The correct response was number 1.

The first item of the seventh and last group (item 5) pictured the 3" X 4" X 1" rectangular solid with a 1 3/4" diameter sphere mounted in the center of the top surface of the rectangular solid. The arrow pointed orthogonally at the long side of the rectangle. The ability necessary to choose the correct answer was the ability to visualize the solid from the direction of the arrow. Specifically, this involved realizing that the solid would appear as a long rectangle with a circle centered on top. The correct response was number 3.

The second item of the seventh group (item 18) pictured a 1 3/4" hemisphere with the arrow pointed at the surface and parallel to the base. The ability necessary to choose a correct answer was the ability to visualize the hemisphere from the direction of the arrow. Specifically, this entailed realizing that the hemisphere would look like a semicircle from the indicated view. The correct response was number 3.

Since the subject was required to imagine the perspective of the solid in the direction of the arrow, it is important that camera location for the large photographs be discussed. Considering each solid figure to be at the origin of a three-dimensional system having axes, x, y, and z, all of the photographs were taken from a position of 30^{o} up from the xy plane and 30^{o} to the right of the zy plane. This camera location provided a view from which three surfaces of each solid could be seen so as to distinguish it as a three-dimensional figure.

The third step in constructor validity is the comparison of the abilities measured and the definition of the ability. Three persons were asked to examine the instrument and judge whether it measured what it was supposed to have measured. These judges included one geometrician and two mathematics educators. All agreed the instrument did indeed measure the ability to visualize two-dimensional perspectives of solid figures.

Scoring procedures constitute the fourth step of constructor validity. The total number of correct responses was counted as the total score. A correction formula for guessing was not used.

The fifth constructor validity step involves test directions. The test directions were as follows:

> The following is a multiple choice test consisting of photographs of various combinations of the blocks which you have been shown. Each page of the test will have a photograph of a block with an arrow pointing toward the block. Your task is to imagine what the block would look like if you were directly behind the arrow looking at the block.
>
> You may choose from the four smaller photographs or if you think none of the photographs represent what you would see, mark no. 5. Turn to item 0 on the first page. What would your choice be? (Answer - no. 4)
>
> We will all take the test at the same rate. When I give the signal turn to item number one. Then we will turn a page every 15 seconds. I will say the word "turn" when you are to go to the next item.

It can be seen from the above that the task is clearly outlined and practiced before the test administration. Doubt concerning the correctness of the available responses were taken into account by answer number 5 on each item. Since the instrument was not a forced guess type of test, no instructions were given for guessing. The time allotted for the test is plainly stated. The scoring procedure was omitted. However, the author believes that by not mentioning the scoring instruction, the examinee would assume the total score would be the total number of items answered correctly.

The last step in constructor validity is to comment on testing conditions. It was judged that the nature of the test items and the situations in which the test was administered were such as to cause the examinees to answer honestly and to the best of their abilities.

Face Validity

"Face validity indicates the extent to which a test appears on casual inspection, especially by examinees or laymen, to measure what it is intended to measure." (8:34) The test consisted of as few written materials as possible and was mostly comprised of photographs. Sometimes the children could be observed during a testing session leaning over to try to view down the arrow toward the solid figure. The test appeared to be well received and understood.

Item Analysis

An item analysis was completed to determine the level of difficulty and the degree of discrimination of the test items. The analysis was executed by means of an appropriate program for "Iterative Bidimensional

Item Analysis" for an IBM 360 computer. Using a criterion level of 90 per cent of the examinees passing the individual item, two items, numbers 11 and 19, were rejected with difficulty levels of 91.7 per cent and 90.3 per cent, respectively. These items were judged to be "too easy."

The biserial correlation of each item with the mean of the total score was calculated to determine the discrimination of each item on the examination. The criterion used was a biserial correlation coefficient of 0.3000. All items with a biserial value below this level were rejected because of poor discrimination, i.e., failure to differentiate between the upper and lower scoring groups.

Five items had biserial values below the criterion level and were rejected. These were items numbered 3, 4, 15, 18, and 20. See Table 1 for the respective biserial coefficients.

TABLE 1

TEST ITEMS REJECTED BECAUSE OF POOR DISCRIMINATION

ITEM NUMBER	BISERIAL
3	0.104
4	0.227
15	0.192
18	0.271
20	-0.160

It should be noted that item 20 had a negative correlation value. This implies that item 20 was correctly answered more often by persons

scoring in the lower half of the total score range than by those scoring in the upper half of the total score range.

The remaining thirteen items were judged to be acceptable and may be found listed with the respective biserial correlation in Table 2. The rejected items were subjected to analysis a second time and were again rejected. Therefore, the total possible score of correct answers for the instrument was reduced from twenty to thirteen. A new score was computed from the raw data for each examinee on this basis.

TABLE 2

ACCEPTABLE TEST ITEMS

ITEM NUMBER	BISERIAL VALUE
1	0.807
2	0.467
5	0.371
6	0.570
7	0.707
8	0.612
9	0.722
10	0.792
12	0.456
13	0.787
14	0.407
16	0.793
17	0.736

Reliability

There are essentially two ways of thinking of reliability. The first is that of "precision of measurement of a set of scores." (8:20) The second way of thinking of reliability is that reliability is the true variance part of the observed variance of test scores from the mean test score. (10:216)

The reliability coefficient for the sample tested for this research was computed in the following manner. A program for an IBM 360 computer was written to perform a split-halves analysis of reliability using the Spearman-Brown prophecy formula on the retained items. The resulting reliability coefficient had a value of 0.8046.

To take into account the effect of the range of the large sample and to provide a measure of "accuracy of measurement" in this research, the standard error of measurement was also computed. The corresponding value was found to be 1.2686. It is, therefore, possible to assert then that using a two-tailed test that the obtained score was within 2.4865 or 3 units of the true score with a .95 level of confidence. Also, the obtained score could be construed to be within 3.2667 or 3 units of the true score at the .99 level of confidence.

A complete listing of the raw data may be found in Appendix B.

CHAPTER V

PRESENTATION, ANALYSIS, AND DISCUSSION OF DATA

Description of the Sample

The sample was drawn from the Duval County school system, the second largest in the State of Florida. Approximately 1250 students were tested from four public schools in this county. The final number of usable pieces of data was 1067. The sampling procedures have been described in detail earlier in Chapter III.

The sample included 555 males comprising 52 percent of the sample, and 512 females comprising 48 percent of the sample. The boys and girls ranged in age from eight years to nineteen years. The children attended school in grades three through twelve. A breakdown of boys and girls in each grade is presented in Table 3 below.

TABLE 3

FREQUENCY TABLE OF SEX BY GRADE LEVEL

Grade	3	4	5	6	7	8	9	10	11	12	Total
Male	64	54	52	61	48	50	47	75	51	53	555
Female	43	43	67	53	54	60	54	32	48	58	512
Total	107	97	119	114	102	110	101	107	99	111	1067

Table 4 gives a similar division for the number of boys and girls in each age group (to the nearest birthday).

TABLE 4

FREQUENCY TABLE OF SEX BY AGE GROUP

Age	8	9	10	11	12	13	14	15	16	17	18	19	Total
Male	32	53	58	55	44	54	57	63	47	64	26	2	555
Female	28	34	63	61	46	53	66	38	39	55	28	1	512
Total	60	87	121	116	90	107	123	101	86	119	54	3	1067

Table 5 is particularly interesting in that it shows the distribution of the youngsters of each age group by grade level. It is to be noted that there was a very narrow range of ages in each grade and that most subjects fell into one of two groups at each grade level.

The subjects' intelligence levels, as measured by the Kuhlmann-Anderson test administered by the individual schools, ranged from the upper seventies to the upper one hundred forties. After dividing this range as outlined in Chapter III, there were three mental ability groups. Study of Table 6 and/or Table 7 reveals that there were (going from low to high) 44 subjects or 4.1 percent of the sample in ability group I, 520 subjects or 48.7 percent of the sample in ability group II, and 503 subjects or 47.1 percent of the sample in ability group III.

TABLE 5

FREQUENCY TABLE OF GRADE LEVEL BY AGE GROUP

Age	8	9	10	11	12	13	14	15	16	17	18	19	Total
Grade													
3	60	40	6	1	-	-	-	-	-	-	-	-	107
4	-	47	48	2	-	-	-	-	-	-	-	-	97
5	-	-	65	48	3	2	1	-	-	-	-	-	119
6	-	-	2	65	41	6	-	-	-	-	-	-	114
7	-	-	-	-	46	50	6	-	-	-	-	-	102
8	-	-	-	-	-	49	56	5	-	-	-	-	110
9	-	-	-	-	-	-	60	36	5	-	-	-	101
10	-	-	-	-	-	-	-	60	40	6	1	-	107
11	-	-	-	-	-	-	-	-	41	51	6	1	99
12	-	-	-	-	-	-	-	-	-	62	47	2	111
Total	60	87	121	116	90	107	123	101	86	119	54	3	1067

TABLE 6

FREQUENCY TABLE OF ABILITY LEVEL BY GRADE LEVEL

Grade	3	4	5	6	7	8	9	10	11	12	Total
I. Q.											
1	3	6	3	4	9	5	1	8	3	2	44
2	41	42	60	52	51	60	51	57	50	56	520
3	63	49	56	58	42	45	49	42	46	53	503
Total	107	97	119	114	102	110	101	107	99	111	1067

Table 6 indicates subject frequency in each ability group at each grade level.

Table 7 points up the sparsity of subjects in category I even more than Table 6, for there are more age levels than grade levels. There was a lack of category I subjects at both ends of the age range as shown in Table 7. However, when viewed in terms of grades as in Table 6, the category I people are even more dispersed. The reason that so few category I subjects appeared in the sample was that I. Q. scores averaged in the 108-110 range rather than averaging 100 as designed.

TABLE 7

FREQUENCY TABLE OF ABILITY LEVEL BY AGE GROUP

Age	8	9	10	11	12	13	14	15	16	17	18	19	Total
I. Q.													
1	0	3	6	4	1	7	7	2	6	5	2	1	44
2	16	36	57	48	50	54	67	55	43	56	36	2	520
3	44	48	58	64	39	46	49	44	37	58	16	0	503
Total	60	87	121	116	90	107	123	101	86	119	54	3	1067

As discussed in Chapter III, the socio-economic spectrum was separated into three levels. Examination of Table 8 and/or Table 9 reveals that there were 519 subjects or 49.6 percent of the sample in the lowest group, category I, 285 subjects or 26.7 percent of the sample in category II, and 243 subjects or 23.7 percent of the sample in category III.

The evidence indicates that even though the sample schools were picked for their wide range of socio-economic levels, almost one half of the children in the sample belonged to the so-called "lower-lower and

upper-lower" socio-economic classes. Table 8 gives the frequency of subjects in the various socio-economic groups as they occurred at each grade level. Even in individual grades, the category I people compose nearly one half of the subjects.

TABLE 8

FREQUENCY TABLE OF SOCIO-ECONOMIC LEVEL BY GRADE LEVEL

Grade	3	4	5	6	7	8	9	10	11	12	Total
SES											
1	48	97	65	55	53	59	54	60	47	56	519
2	30	29	32	27	29	23	33	27	27	28	285
3	29	39	22	32	20	28	14	20	25	27	243
Total	107	97	119	114	102	110	101	107	99	111	1067

TABLE 9

FREQUENCY TABLE OF SOCIO-ECONOMIC LEVEL BY AGE GROUP

Age	8	9	10	11	12	13	14	15	16	17	18	19	Total
SES													
1	22	32	55	55	47	57	68	58	44	57	32	2	529
2	18	26	39	29	22	23	35	25	21	37	9	1	285
3	20	29	27	32	21	27	20	18	21	25	23	0	253
Total	60	87	121	116	90	107	123	101	86	119	54	3	1067

Table 9 illustrates also that the number of category I subjects nearly matches that of category II and III combined. Looking at the frequencies for nineteen-year olds, it is interesting to note that there were no nineteen-year olds from category III. The frequencies of eighteen-year olds is also unexpected when one notes the number of category II subjects.

Results of Data Analyses

The research hypothesis was that all children in the age range associated with grades seven through twelve have the ability to visualize the two dimensional perspectives of selected solid figures, while those in grades one through six do not. The subhypotheses of the main hypotheses were listed in Chapter III, page 29. The statistical hypotheses associated with each subhypothesis were tested with either analysis of covariance, analysis of variance, or both. The data were treated with two separate analyses of covariance. The first analysis was to determine the effect of grade on the ability to perform well on the instrument, and the second was to determine the effect of age on the ability to perform well on the instrument. Also, the data were treated with two four-way analyses of variance. The first involved the independent variables, sex, socio-economic level, I. Q. measure, and grade level.

The second four-way analysis of variance involved the independent variables of sex, socio-economic level, I. Q. measure and age group. In both of the variance analyses, the levels of I. Q. measure were reduced from three to two to avoid empty cells. This was judged reasonable since the disregarded level, category I, had only forty-four

subjects in it. Therefore, category I for I. Q. became the average group and category II became the above average group. In the former analysis of variance, the grade levels were collapsed as follows:

> Grades three and four become level I; grades five and six become level II; grades seven and eight become level III; grades nine and ten become level IV; and grades eleven and twelve become level V. Similarly, age groups were collapsed for the later analysis of variance as follows: age eight and nine become group I; ages ten and eleven become group II; ages twelve and thirteen become group III; ages fourteen and fifteen become group IV; ages sixteen and seventeen become group V; and ages eighteen and nineteen become group VI.
>
> However, the four-way analysis of variance information could not be used because too many empty cells occurred even after the above precautions. See Table 10 and Table 11.

Upon examining the analysis of covariance and analysis of variance data available, it was found that all four analyses showed that socio-economic level was not significant at the 5 percent level and as such was eliminated from each of the analysis of variance designs. (See sub-hypothesis d) The collapsed levels of grade and age were again expanded except that the eighteen and nineteen-year olds were still grouped together. Two three-way analyses of variance designs were applied to the data with the independent variables as grade level, sex, and I. Q. group for the first analysis and age level, sex, and I. Q. group for the second analysis.

TABLE 10

ANALYSIS OF VARIANCE TABLE FOR GRADE, SEX, SOCIO-ECONOMIC LEVEL AND I.Q.

Source	Sum of Squares	D.F.	Mean Square	F-Ratio
Mean	0.0	0	0.0	0.0
Grade (1)	1524.70630	3	508.23535	87.29588
Sex (2)	0.0	0	0.0	0.0
SES (3)	11.08871	1	11.08871	1.90453
IQ (4)	0.0	0	0.0	0.0
1 X 2	32.83107	3	10.94368	1.87972
1 X 3	83.76027	7	11.96575	2.05527
1 X 4	22.65279	3	7.55093	1.29697
2 X 3	2.69561	1	2.69561	0.46300
2 X 4	0.0	0	0.0	0.0
3 X 4	4.71189	1	4.71189	0.80933
1 X 2 X 3	58.22432	7	8.31776	1.42868
1 X 2 X 4	13.01280	3	4.33760	0.74504
1 X 3 X 4	25.04768	7	3.57824	0.61461
2 X 3 X 4	5.54194	1	5.54194	0.95190
1234	52.05065	7	7.43581	1.27719
Error	5612.39485	64	5.82199	

TABLE 11

ANALYSIS OF VARIANCE TABLE FOR AGE, SEX, SOCIO-ECONOMIC LEVEL AND I.Q.

Source	Sum of Squares	D.F.	Mean Square	F-Ratio
Mean	0.0	0	0.0	0.0
Age (1)	1314.13793	4	328.53442	54.10515
Sex (2)	0.0	0	0.0	0.0
SES (3)	20.60297	1	20.60297	3.39303
IQ (4)	0.0	0	0.0	0.0
1 X 2	23.36100	4	5.84025	0.95181
1 X 3	86.97562	9	9.66396	1.59152
1 X 4	34.38575	4	8.59644	1.41572
2 X 3	0.22266	1	0.22266	0.03667
2 X 4	0.0	0	0.0	0.0
3 X 4	0.59295	1	0.59295	0.09755
1 X 2 X 3	30.61235	9	3.40137	0.56016
1 X 2 X 4	21.88710	4	5.47178	0.90113
1 X 3 X 4	41.52495	9	4.61388	0.75984
2 X 3 X 4	0.21250	1	0.21250	0.03500
1234	36.42804	9	4.04756	0.66658
Error	5780.68365	952	6.07215	

Since the analysis of variance table does not lend itself to dissection for listing under each null hypothesis, the analysis of variance tables will be shown first with necessary t-test or multiple range tests as required by the corresponding null hypothesis.

Table 12 is the three-way analysis on the independent variables of grade level, sex, and I. Q. group. There are ten levels of grades, two groups of sex, and two groups of I. Q.

TABLE 12

ANALYSIS OF VARIANCE TABLE FOR GRADE, SEX, AND I.Q.

Source	Sum of Squares	D.F.	Mean Square	F-Ratio
Mean	99926.11885	1	99926.06250	17088.96484
Grade	1840.26540	9	204.47392	34.96834
Sex	61.50517	1	61.50516	10.51837
IQ	190.21542	1	190.21541	32.52989
1 X 2	68.93521	9	7.65947	1.30989
1 X 3	48.56323	9	5.39591	0.92279
2 X 3	0.31401	1	0.31401	0.05370
1 X 2 X 3	40.45973	9	4.49552	0.76881
Error	5747.99677	983	5.84740	

Table 13 is the three-way analysis of variance table for the variable age level, sex, and I. Q. levels.

There are eleven age groups, two groups of sex, and two I. Q. levels.

Subhypothesis a: The mean ability as indicated by the instrument will increase as the grade level increases.

Null Hypothesis 1. There will be no statistically significant difference among the grade levels after adjusting for the covariates of sex, socio-economic level, I. Q. group, and age.

TABLE 13

ANALYSIS OF VARIANCE TABLE FOR AGE, SEX, AND I. Q.

Source	Sum of Squares	D.F.	Mean Square	F-Ratio
Mean	85782.01175	1	85782.00000	14357.38572
Age	1552.26928	10	155.22690	25.98042
Sex	68.30071	1	68.30070	11.43153
IQ	190.19598	1	190.19597	31.83322
1 X 2	75.48274	10	7.54827	1.26336
1 X 3	66.03437	10	6.60344	1.10522
2 X 3	0.37427	1	0.37427	0.05264
1 X 2 X 3	28.01765	10	2.80176	0.45893
Error	5849.29635	979	5.97476	

Table 15 is the analysis of covariance table for the variate, grade. Note that the F-ratio among grades is 8.781 with 9, and 1053 degrees of freedom is significant at and beyond the .05 level. (22:279-280) Therefore, the null hypothesis was rejected.

TABLE 14

RESULTS TABLE FOR KRAMER MULTIPLE RANGE TEST
ON ADJUSTED MEANS OF GRADES

Grade	3	4	5	6	7	8	12	9	11	10
x	7.24	8.14	9.70	9.87	10.68	11.00	11.15	11.25	11.28	11.36
n	107	97	119	114	102	110	111	101	99	107

TABLE 15

ANALYSIS OF COVARIANCE TABLE FOR THE DEPENDENT VARIABLE, GRADE AND INDEPENDENT VARIABLES, SEX, AGE, SOCIO-ECONOMIC LEVEL, AND I.Q.

Source	DF	YY	Sum-Squares (Due)	Sum-Squares (About)	DF	Mean-Square
Treatment (Between)	9	1993.5000				
Error (Within)	1057	6784.8125	458.8022	6326.0078	1053	6.0076
Treatment + Error (Total)	1066	8778.3125	1977.5503	6800.7617	1062	
Difference for Testing Adjusted Treatment Means . . .				474.7539	9	52.7504

F-ratio with 9 and 1053 DF = 8.781

Any two means not underlined by the same line are significantly different at the .05 level, and any two means underscored by the same line are not significantly different at the .05 level. The above is from Kramer, 1956.

Null Hypothesis 2. There will be no statistically significant differences between the means of the correct scores for the different grade levels.

An examination of Table 12 shows that the F-ratio for grades is 34.96834 for 9 and 983 degrees of freedom. This F-ratio is significant at the .05 level and the null hypothesis was rejected.

TABLE 16

RESULTS TABLE FOR KRAMER MULTIPLE RANGE TEST
ON UNADJUSTED MEANS OF GRADES

Grade	3	4	5	6	7	8	9	12	10	11
x	7.36	8.83	9.65	9.98	10.82	11.01	11.27	11.29	11.40	11.49
n	104	91	116	110	93	106	99	109	99	96

Any two means not underlined by the same line are significantly different at the .05 level, and any two means underscored by the same line are not significantly different at the .05 level.

Subhypothesis b: The mean ability as indicated by the instrument will increase as the chronological age increases.

Null Hypothesis 3. There will be no statistically significant differences between the age levels after adjusting for the covariates of sex, socio-economic level, I. Q. group, and grade.

TABLE 17

ANAYLSIS OF COVARIANCE TABLE FOR THE DEPENDENT VARIABLE, AGE
AND INDEPENDENT VARIABLES, SEX, SOCIO-ECONOMIC LEVEL, I.Q., AND GRADE

Source	DF	YY	Sum-Squares (Due)	Sum-Squares (About)	DF	Mean-Square
Treatment (Between)	10	1786.3750				
Error (Within)	1056	6991.9375	608.8040	6383.1328	1052	6.0670
Treatment + Error (Total)	1066	8778.3125	2038.6240	6739.6875	1062	
Difference for Testing Adjusted Treatment Means . . .				356.5547	10	35.6555

F-ratio with 10 and 1052 DF = 5.876

An analysis of covariance for the variate age level with independent variables sex, socio-economic level, I. Q., and grade appears in Table 17. Note that the F-ratio for among age groups is 5.876 with 10 and 1052 degrees of freedom respectively is significant at the .05 level and the null hypothesis was rejected.

TABLE 18

RESULTS TABLE FOR KRAMER MULTIPLE RANGE TEST
ON ADJUSTED MEANS OF AGES

Ages	8	17	18 & 19	9	16	10	15	14	11	13	12
x	9.42	9.50	9.53	9.61	9.79	9.84	10.11	10.60	10.82	10.82	11.15
n	60	119	57	87	86	121	101	123	116	107	90

Any two means not underscored by the same line are significantly different at the .05 level, and any two means underscored by the same line are not significantly different at the .05 level.

Null Hypothesis 4. There will be no statistically significant differences between the means of the correct scores for the different age groups.

Table 13 shows an F-ratio of 25.98042 with 10 and 979 degrees of freedom for interaction between age groups which is significant at the .05 level. The null hypothesis was rejected.

TABLE 19

RESULTS TABLE FOR KRAMER MULTIPLE RANGE TEST
ON UNADJUSTED MEANS OF AGES

Age	8	9	10	11	12	13	14	15	16	18 & 19	17
x	7.62	7.99	8.58	10.06	10.06	10.86	11.14	11.16	11.20	11.33	11.48
n	60	84	115	112	89	100	116	99	80	54	114

Any two means not underscored by the same line are significantly different at the .05 level, and any two means underscored by the same line are not significantly different at the .05 level.

Subhypothesis c. The mean ability as indicated by the instrument will be the same for the two sexes.

Null Hypothesis 5. There will be no statistically significant regression of the independent variable, sex.

Table 20 which shows the within error for the analysis of covariance on grade lists the regression coeficients, their standard error, and associated t-test values. The t-value of the sex coefficient is -3.1694 which is significant at the .05 level and beyond. (22:271)

Table 21 shows the corresponding within error for the analysis of covariance on age groups. Again the t-score, 3.1134, of the coefficient of the sex covariate in the regression model is significant at the .05 level and beyond and the null hypothesis was rejected.

TABLE 20

TABLE OF COEFFICIENTS, STANDARD ERRORS, AND COMPUTED T-VALUES FOR ANALYSIS OF COVARIANCE WITH GRADE AS DEPENDENT VARIABLE AND SEX, AGE SOCIO-ECONOMIC LEVEL, AND I.Q. AS INDEPENDENT VARIABLES

Ind. Var.	Error (Within) Coefficient	Stand. Error	T-Value
Sex	-0.4845	0.1529	-3.1694
Age	0.0318	0.1325	0.2403
SES	0.2028	0.0950	2.1336
IQ	1.0301	0.1440	7.1556

TABLE 21

TABLE OF COEFFICIENTS, STANDARD ERRORS, AND COMPUTED T-VALUES FOR ANALYSIS OF COVARIANCE WITH AGE AS DEPENDENT VARIABLE AND SEX, SOCIO-ECONOMIC LEVEL, AND I.Q., AND GRADE AS INDEPENDENT VARIABLES

Ind. Var.	Error (Within) Coefficient	Stand. Error	T-Value
Sex	-0.4771	0.1532	-3.1134
SES	0.1745	0.0950	1.8380
IQ	0.9903	0.1443	6.8638
Grade	0.4793	0.1396	3.4346

Null Hypothesis 6: There will be no statistically significant difference between the means of the correct scores for the two sexes.

An examination of Table 12 and Table 13 shows that the F-ratio between sexes is 10.51837 with 1 and 983 degrees and 11.43153 with 1 and 979 degrees of freedom which were significant at the .05 level and, the null hypotheses were rejected.

Since the difference between the means was significant, a t-test was applied to the data. With a mean of 10.4267 for the boys and 10.0763 for the girls, a t-score of 2.0020 with 1021 degrees of freedom was obtained. This value was significant at the .05 level.

Subhypothesis d: The mean ability as indicated by the instrument will increase as the socio-economic level increases.

Null Hypothesis 7: There will be no statistically significant regression of the independent variable, socio-economic level.

Table 20 reveals a t-value of 2.1336 for the regression coefficient of socio-economic level with grade as the variable. This t-value is significant at the .05 level. Table 21, on the other hand, shows a t-value of 1.8380 for the regression coefficient of socio-economic level with age as the variable. This t-value is not significant at the .05 level. An analysis of covariance was run on the dependent variable, socio-economic level with independent variables age group, grade level, sex group, and I. Q. level in order to resolve the conflict between the above data. An F-ratio of 1.282 with 2 and 1016 degrees of freedom was obtained. (See Table 22) This F-value is not significant at the .05 level. Therefore, the null hypothesis was not rejected.

Null Hypothesis 8: There will be no statistically significant difference between the means of the correct scores for the different socio-economic groups.

TABLE 22

ANALYSIS OF COVARIANCE TABLE FOR THE DEPENDENT VARIABLE SOCIO-ECONOMIC LEVEL AND INDEPENDENT VARIABLES AGE, GRADE, SEX, AND I. Q.

Source	DF	YY	Sum-Squares (Due)	Sum-Squares (About)	DF	Mean-Square
Treatment (Between)	2	14.8750				
Error (Within)	1020	8008.0625	1707.7285	630.3320	1016	6.2011
Treatment + Error (Total)	1022	8022.9375	1706.6019	6316.2344	1018	
Difference for Testing Adjusted Treatment Means . . .				15.9023	2	7.9512

F-ratio with 2 and 1016 DF = 1.282

The four-way analysis of variance on the collapsed cells (See Tables 10 and 11) described at the first of this section showed F-ratios between socio-economic levels to be 1.90453 with 1 and 964 degrees of freedom for the grade analysis and 3.39303 with 1 and 952 for the age analysis. Neither of these F-ratios was significant at the .05 level. Hence, the null hypothesis was not rejected.

Subhypothesis e. The mean ability as indicated by the instrument will increase as the intellectual ability level increases.

Null Hypothesis 9. There will be no statistically significant regression of the independent variable, intellectual ability level.

Table 20 and Table 21 indicated a t-score of 7.1556 and 6.8638 for three levels of intellectual ability. The scores for both the covariance on grades and ages were significant at the .05 level and beyond. Therefore, the null hypothesis was rejected.

Null Hypothesis 10. There will be no statistically significant difference between the means of the correct scores of the various ability levels.

The three-way analysis of variance tables, Table 12 and Table 13, show F-ratios of 32.52989 with 1 and 983 degrees of freedom and 31.83322 with 1 and 979 degrees of freedom for the grade analysis and age analyses, respectively. Both of these F-ratios are significant at the .05 level and beyond. Therefore, the null hypothesis was rejected.

A t-test was applied to the data to determine the greater of the means. The mean for category I was 9.9481, and the mean for category II was 10.5746. The analysis resulted in a t-score of -3.5961 with 1021 degrees of freedom. This t-score is significant at the .05 level.

Subhypothesis f. The mean ability as indicated by the instrument will be effected by lower order interaction between grade level, sex group, and I. Q. level, and/or by lower order interaction between age level, sex group, and I. Q. level.

Null Hypothesis 11: There will be no statistically significant interaction between grade level and sex group.

The analysis of variance on grade level, sex group, and ability level resulted in an F-ratio of 1.30989 with 9 and 983 degrees of freedom for the grade level and sex group interaction as shown in Table 12. The F-ratio was not significant at the .05 level and the null hypothesis was not rejected.

Null Hypothesis 12: There will be no statistically significant interaction between grade level and ability level.

Table 12 reveals that the analysis of variance for grade level, sex group, and ability yields an F-ratio of 0.92279 with 9 and 983 degrees of freedom for grade, I. Q. interaction. F-value is not significant at the .05 level. Therefore, the null hypothesis was not rejected.

Null Hypothesis 13: There will be no statistically significant interaction between sex groups and ability level.

Table 12 and Table 13, respectively, show F-ratios of .05370 with 1 and 983 degrees of freedom and .05264 with 1 and 979 degrees of freedom for the grade, sex, and ability, and age, sex, and ability, respectively. Neither of these F-values is significant at the .05 level. Hence, the null hypothesis was not rejected.

Null Hypothesis 14: There will be no statistically significant interaction between age groups and sex groups.

Inspection of Table 13 reveals F-ratio of 1.26335 for 10 and 979 degrees of freedom in the age, sex, I. Q. run of analysis of variance. This F-ratio is not significant at the .05 level. Therefore, the null hypothesis was not rejected.

Null Hypothesis 15: There will be no statistically significant interaction between age groups and ability levels.

The F-ratio from Table 13 is 1.10522 for 10 and 979 degrees of freedom. This F-value is not significant at the .05 level. Hence, the null hypothesis was not rejected.

Null Hypothesis 16: There will be no statistically significant interaction between grade levels, sex groups, and ability levels.

Examination of Table 12 shows an F-ratio of 0.75881 with 9 and 983 degrees of freedom. Such an F-value is not significant at the .05 level. Therefore, the null hypothesis was not rejected.

Null Hypothesis 17: There will be no statistically significant interaction between age groups, sex groups, and ability levels.

Inspection of Table 13 reveals an F-ratio of 0.46893 with 10 and 979 degrees of freedom. This F-value is not significant at the .05 level. Hence, the null hypothesis was not rejected.

Since none of the above interactions were significant, the interaction sums of squares and degrees of freedom were pooled with the error sum of squares and error degrees of freedom in both the analysis of variance chart for grade, sex, and I. Q. in Table 13, and in the analysis of variance chart for age, sex, and I. Q. in Table 15. The resulting F-ratios were very little different from the unpooled F-ratios.

The pooled F-ratios were still significant at the .05 level and beyond. See Table 23 and Table 24 following.

TABLE 23

ANALYSIS OF VARIANCE TABLE FOR GRADE, SEX, AND I. Q.
WITH POOLED INTERACTION TERMS

Source	Sum of Squares	D.F.	Mean Square	F-Ratio	
Mean	99926.11885	1	99926.06250	17088.95484	17,104.74006
Grade	1804.26540	9	204.47392	34.96834	35.00061
Sex	61.50517	1	61.50516	10.51837	10.52808
IQ	190.21542	1	190.21541	32.52989	32.55993
Error	5906.26895	1011	5.84201		

TABLE 24

ANALYSIS OF VARIANCE TABLE FOR AGE, SEX, AND I. Q.
WITH POOLED INTERACTION TERMS

Source	Sum of Squares	D.F.	Mean Square	F-Ratio	
Mean	85782.01175	1	85782.00000	14357.38572	14393.89664
Age	1552.26928	10	155.22690	25.98042	26.04649
Sex	68.30071	1	68.30070	11.43153	11.46060
IQ	190.19598	1	190.19597	31.83322	31.91417
Error	6019.20538	1010	5.95961		

The high significance of the main effects in the above two analyses brings up the question of how much variance is due to each main effect. Since the values under the mean square column represent estimates of the sample mean, i.e., $\widehat{\sigma_s^2} = \widehat{\sigma_T^2} + \widehat{\sigma_E^2}$, subtracting the error mean square from the mean square of each of the variables, grade, sex, age, and I. Q. will yield the true variance of the corresponding variable. When the ratio of the true variance for each variable and the total variance of all variables is computed, it reveals what part of the total variance that particular variable contributes.

Consider Table 23. For this analysis the variable, grade accounted for 45.28065 per cent of the total variance. The variable, sex contributes 12.68912 per cent of the total variance, and the variable, I. Q. accounts for 42.03024 per cent of the total variance. The percentages of the variances of the variables shown in Table 24 were also computed. Here, age accounted for 37.7085 per cent of the total variance. The variable, sex contributed 15.74887 per cent of the total variance and the variable, I. Q. accounted for 46.54258 per cent of the total variance.

Subhypothesis g. There will be more variability between the mean ability of grades three and six, than between the mean ability of grades seven and twelve as indicated by the instrument.

Null Hypothesis 18. There will be more variability between grades seven and twelve than grades three and six.

Inspection of Table 25 below reveals that there is a difference of 2.5963 between the unadjusted means of grades three and six, while the difference between the unadjusted means of grades seven and twelve is .7777. The corresponding values for the means adjusted for the effect of age, sex, socio-economic level, and I. Q. are 2.6280 and 0.4673. See Table 14 and Table 16. Kramer multiple range tests indicate no

significant difference between means for grades seven through twelve. See Figure 2 for the plot of the unadjusted means against grade levels, and Figure 3 for the plot of the adjusted means against grade levels. Note how closely they correspond. In conclusion, the null hypothesis was rejected for both unadjusted and adjusted means.

TABLE 25

TABLE OF MEANS, ADJUSTED MEANS, AND STANDARD ERRORS FOR GRADES THREE THROUGH TWELVE

Treatment No.	Treatment Mean	Adjusted Mean	SE Adjusted
3	7.2897	7.2442	0.6357
4	8.2347	8.1424	0.5216
5	9.5714	9.6957	0.3974
6	9.8860	9.8722	0.3078
7	10.5196	10.6795	0.2504
8	10.9099	10.9932	0.2452
9	11.2900	11.2487	0.3119
10	11.3832	11.3551	0.4018
11	11.4040	11.2785	0.5436
12	11.2973	11.1468	0.6351

Subhypothesis h. There will be more variability between the mean ability of ages eight and eleven than between the mean ability of ages twelve and eighteen.

Null Hypothesis 19. There will be more variability between ages twelve and eighteen then between ages eight and eleven.

Table 26 below reveals a difference of 2.3402 between the unadjusted means for ages eight and eleven. It also shows a difference of .7416 between the unadjusted means of ages twelve and eighteen. The

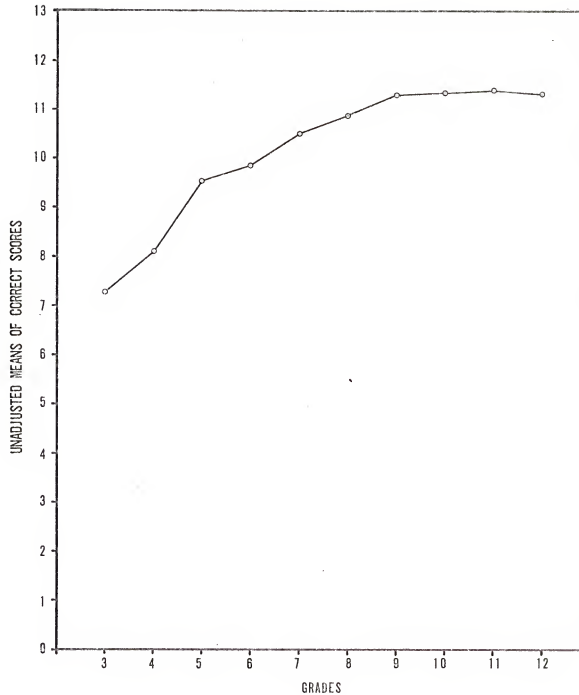


FIGURE 2
GRAPH OF UNADJUSTED MEANS FOR EACH GRADE LEVEL

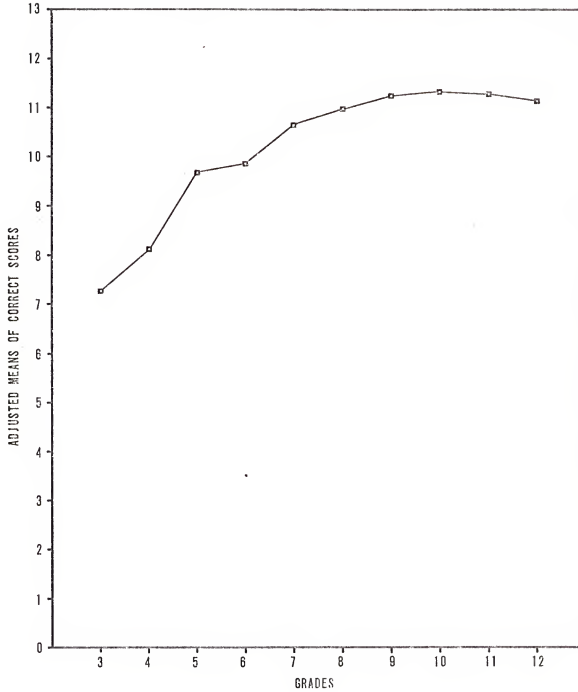


FIGURE 3
GRAPH OF ADJUSTED MEANS FOR EACH GRADE LEVEL

adjusted (adjusted for grade, sex, socio-economic and I. Q.) means of ages eight and eleven have a difference of 1.4005 while the adjusted means of ages eighteen and thirteen have a difference of -6.6247. The Kramer multiple range test for adjusted data showed just as much variability in the upper grades as lower grades as defined above. The Kramer multiple range test for unadjusted means, Table 19, shows more variability in the lower grades than the upper grades. The null hypothesis was rejected for the unadjusted means and not rejected for the adjusted means. Figure 4 is a plot of the unadjusted means against the age groups, while Figure 5 is the plot of the adjusted means against the age groups. Note how the means in the latter figure drop after age twelve.

TABLE 26

TABLE OF MEANS, ADJUSTED MEANS, AND STANDARD ERRORS FOR AGES EIGHT THROUGH EIGHTEEN

Treatment No.	Treatment Mean	Adjusted Mean	SE Adjusted
8	7.6167	9.4182	0.7168
9	7.9080	9.6123	0.6150
10	8.3884	9.8366	0.4703
11	9.9569	10.8187	0.3600
12	10.6444	11.1528	0.2948
13	10.6916	10.8231	0.2387
14	10.8943	10.5957	0.2606
15	11.1188	10.1051	0.3801
16	11.1395	9.7889	0.4917
17	11.4370	9.5024	0.6006
18 & 19	11.3860	9.5281	0.7000

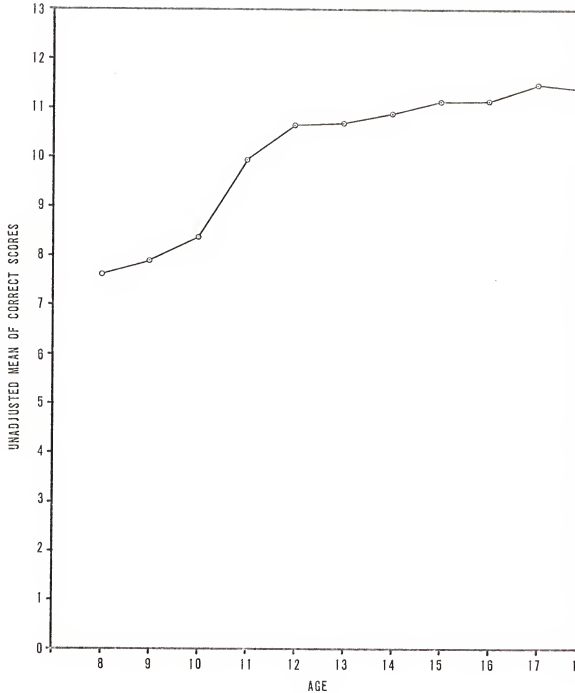


FIGURE 4
GRAPH OF UNADJUSTED MEANS FOR EACH AGE LEVEL

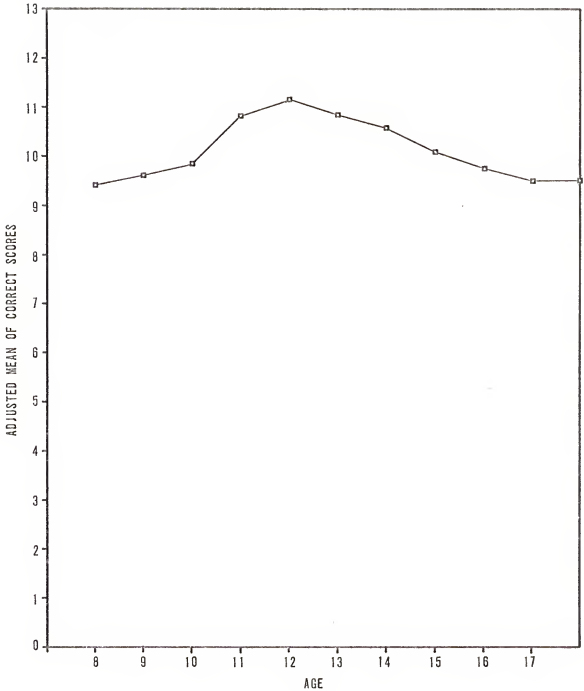


FIGURE 5
GRAPH OF ADJUSTED MEANS FOR EACH AGE LEVEL

Summary of Results

In conclusion, it has been found that grade level does make a difference in the ability to perform well on the instrument of this study. Chronological age does make a difference in the ability to perform well on the instrument. Males perform better on the instrument than females. Socio-economic class as classified by the Otis Dudley Duncan scales has no significant effect on the ability to perform well on the instrument. Subjects of higher mental ability level, as measured by the Khulmann-Anderson Test, get higher correct scores than lower ability youngsters on this instrument. No combination of the variables, grade, sex, and I. Q. or age, sex, and I. Q. had a significant effect on the ability to perform well on this test. There was more variability between the lower grades than the higher grades. There was significant variability between both lower and higher age groups.

Discussion of Results

The confirmation that age and the related variable, grade, make a difference on this test is in agreement with most of the studies in the review of the literature (Chapter II) which validate Piaget's general findings of a sequential development of mental abilities. However, the results of this study do not agree with the majority of research reviewed that find a Piagetian ability develops at a later age than predicted. For example, in her comprehensive study, Rivoire found that most children had not completed their spatial development by fifteen years of age. This study, on the other hand, shows that the ability to perform well on the research instrument is fully manifested after the seventh grade or twelve years of age.

Piaget states that the ability ought to start appearing about the ages of nine or ten years. Study of Figure 4 and Figure 5 of unadjusted and adjusted means of correct scores respectively, show a definite upswing in ability at the predicted ages. The ability increases until about the age of twelve years and then levels off. The multiple range test for unadjusted age means reveals significant differences between the mean scores of ages twelve and above and, hence, reinforces the notation of a leveling off effect. The age range of nine or ten years old to twelve or thirteen years old is roughly Piaget's Stage III where the ability is supposed to start being shown.

Figure 2, the graph of unadjusted means for grades, and Figure 3, the graph of adjusted means for grades, both climb from grade three and begin to level off at about the seventh grade. The respective multiple range tests show no significant differences between the mean scores of the seventh through the twelfth grades thus validating the leveling-off observation and indicating obtainment of the tested ability. Since seventh grade corresponds with the ages of twelve or thirteen, the results of this study give strong support to the Piagetian theory.

While Figure 4, the graph of the unadjusted means for age, shows a leveling off of the correct score means, Figure 5, the graph of the adjusted means for age falls off, and hence, shows a decrease in the tested ability. The author interprets this decrease to mean that the effect of the independent variables of sex, grade, socio-economic level, or ability level become great as age increases. In Table 17, which shows the coefficients, standard errors, t-scores for the covariance analysis on the dependent variable age, it is seen that the t-scores of the coefficients of grade and socio-economic level are not significant at the .05 level.

Hence, sex and ability level are probably causing the depression in the adjusted scores. A possible reason for this depression might be the learning of sex roles and the associated experiences and biasses thereof. Since ability level contributes more of the variance (See Sub-hypothesis f) than sex, one might also conclude that mental ability becomes more important as the child grows older through adolescence.

It is interesting to note that, while there is an obvious difference in the unadjusted and adjusted means for ages, there is very little difference in the unadjusted and adjusted means for grades. This would appear to indicate that grade is a better predictor of the tested ability than age. This might be due to the stratifying of ability level which occurs under the grade system. That is, lower ability youngsters are more likely to be a grade behind, and higher ability youngsters are more likely to be a grade ahead.

Piaget does not discuss the possible effect of other variables such as sex, I. Q., or socio-economic class, upon his sequence of stages. On the other hand, some of the people who have replicated parts of his work have commented on these variables.

The study in the literature most nearly approximating the present research is that of Barbara Boe (1968). Boe found a sex difference on the drawing version of Piagetian's sectioning task which favored the males. (5:418) She dismissed this result because she did not find a significant difference between the sexes on the multiple-choice version of her test. She attributed the sex difference to drawing ability. In view of the results of the present research (the instrument of this study was multiple-choice and not related to drawing), the author believes that Boe was unjustified in her rejection of the possibility that

males perform better on this type of task than females. This position tends to agree with that of Foran and O'Hara (1935) and Smith (1948).

Boe also found that mental ability level made an important difference in the ability to imagine sections of solids. The results of the present study show a very large difference in the ability of mental ability groups to visualize perspectives of solid figures. Both studies show that the higher mental ability groups perform better on the respective instruments. The review of the literature reveals little about the affect on mental abilities on Piagetian tasks.

Most of the studies in the review of the literature which dealt with the socio-economic class variable controlled it by restricting the sample to the "middle class." Examples are the studies of Beilin and Franklin, Boe and Rivoire. Wallach does, however, report from his comprehensive review of one hundred seven articles that some shifts in age norms had been found as a function of socio-cultural status. The present study did not reveal a shift in age norms nor did it indicate that socio-economic class contributed to this, or any other, factor. A non-documented, but possible explanation for this non-significance of socio-economic class, might be that the traits normally associated with the lower, middle, and upper classes might not have existed within the sample. Florida is a fast growing state in the midst of flux and change. A large county in this type of state is peopled by a great percentage of newcomers. Under these conditions, the characteristics of the classes indentifiable in a more settled and stable community might not exist and, hence, might not have been revealed by this study.

CHAPTER VI

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Much has been written about the ability of children to learn mathematical concepts. Bruner has stated that any subject can be taught effectively in some intellectually honest form to any child at any stage of development. (7:33) Piaget and his co-workers have attempted to formulate a new theoretical framework by approaching child psychology from an espistomological viewpoint. From his many explorations, Piaget has postulated a sequence for the cognitive abilities of the child. One of the vehicles of his theory is representational space or the ability to formulate images. Representational ability is seen as developing mathematically through the phases of topological, projective, and Euclidean spaces in that order.

Piaget has developed and conducted many experiments to demonstrate the stages he has formulated. One of these experiments pertained to the ability to imagine cross-sections of various solids before cutting the solid. Success with this task indicated the beginnings of Euclidean spatial ability which is supposed to begin being manifested at about nine or ten years of age. Euclidean spatial abilities should, according to the model, be fully developed by age twelve.

The author extended the cross-sectioning experiment to a projective spatial task and developed an instrument to test the ability. The instrument consisted of photographs of solid figures with an arrow

indicating the perspective from which the subject was to view each solid. The child was asked to imagine what the solid would look like from the direction of the arrow and to choose a response from four smaller photographs or a none of these choice.

One purpose of this study was to determine at what age, or grade public school children attain the ability measured by this instrument. Another purpose was to take into account some of the statistical weaknesses which are so often mentioned in the literature concerning Piagetian expermentation. Also, the study was designed to answer questions about the effect of sex, ability level represented by I. Q., and socio-economic class on the performance on this instrument.

Summary

Two pilot studies were conducted at P. K. Yonge Laboratory School, University of Florida, to determine which grades were to be included in the study and how to administer the instrument. Then, approximately one hundred twenty children were tested in each of the grades three through twelve in Duval County, Florida. The children were from two elementary schools, one junior high school, and one high school. These schools were judged to have broad socio-economic backgrounds.

Data on the age, I. Q., socio-economic class, and sex, and grade of the subjects were drawn from the cumulative folders of the respective students. Of the original twelve hundred students tested, 1067 were retained for the study. The remaining were rejected because of lack of information in the cumulative folders as to I. Q. level or socio-economic background. The Kuhlmann-Anderson I. Q. test is used by Duval County to measure intelligence. This quotient and the father's occupation were

recorded on most records. The Otis Dudley Duncan scale was used to rank students' socio-economic level using the father's occupation as the criterion.

The children were examined in classroom groups of about thirty students each. Before the test began, each group was shown all of the solids which individually, or in combination, composed the test items. All subjects were given ample opportunity to consider and respond to each of the twenty items on the paper and pencil examination.

The instrument was subjected to analysis for item difficulty and discrimination. Two items were rejected because the difficulty level was too low and five items were rejected because they did not discriminate the upper from the lower group. The items were then rescored. The resulting data may be seen in Appendix B.

The data were examined with analysis of covariance on the dependent variable of grade with independent variables, age, sex, socio-economic level, and I. Q. Analysis of covariance was also used on the dependent variable age, with independent variables, grade, sex, socio-economic level and I. Q. The data were further subjected to two three-way analyses of variance, firstly on the variables of grade, sex, and I. Q., and, secondly on the variables of age, sex and I. Q. The socio-economic variable was deleted from the above three-way analysis of variance, because earlier analyses using both analysis of variance and analysis of covariance indicated it was not significant. See Chapter V.

Conclusions

For this particular sample of the population of public school children in Duval County, Florida, Piaget seems to have made a correct

postulation to the effect that the ability to score well on the instrument increases with chronological age. The significance of the analyses both on grade and age seemed to verify the truth of the above statement. Furthermore, the results of this study indicate that the Duval children do acquire the ability at about the predicted age of twelve years. See Figure 4 and Figure 5.

Analysis of the data indicates that boys score better than girls on this instrument in this sample. Although the boys seem to have an advantage at this task, at the 5 per cent level, the difference is not significant at the 1 per cent level.

In this study, ability level as determined by an I. Q. score on the Kuhlmann-Anderson Test makes a great difference on the ability to perform well on this test. The higher I. Q. group had a great advantage over the lower I. Q. group.

For this particular sample, each of the three socio-economic classes performed just as well on the instrument. Very little difference could be found between groups, and no difference was found that could not be due to chance.

It would seem that for this sample that the high mental ability, older boys in the higher grades in the public schools in Duval County are the best achievers on the instrument of this study.

Recommendations

A project as massive as the present one is, of course, likely to hold unforescen difficulties. The author suggests that if a researcher wished to use this type of design again, that he take the following precautions to avoid empty cells, and hence, problems with the statistical analyses.

1. The coding procedures should not be formulated until after the raw data has been collected.

The author found very few subjects in the I. Q. range below a score of 89. However, the I. Q. scores recorded in the cumulative files averaged about 108. Since average I. Q. is defined to be 100; this would explain why so few low scores were found. A correction factor is to average all I. Q. scores after collection and set up appropriate stanines.

2. The sample should come from a more settled and stable community.

As commented upon in Chapter V, there was a suspected blurring of socio-economic class traits in the sample because of the accelerated growth of certain Florida counties.

There are several possible lines for future research. One might add the variable race to the variables of grade or age, sex, I. Q., and socio-economic level, and replicate the present study, or one might replace the socio-economic variable with the race variable above and replicate. It might be interesting if two Piagetian tasks could be studied over several grades or ages on the same subjects. The two abilities could be compared at each of the levels in the experiment to see whether they were acquired in some order or simultaneously by the same groups.

The size of the sample and the number of ages or grade levels could be reduced so that it would be feasible to provide learning experiences to one set of youngsters while maintaining a control group, then testing both groups for the Piagetian task. The general design of this research with the suggested modifications could be applied to two different cultural groups. The results thereof could be compared to determine if there are any cultural effects on the ability studied.

Rural children could be compared with urban children. Suburban children could be compared with the culturally disadvantaged of the inner-city. The possibilities for research are indeed numerous.

APPENDICES

APPENDIX A

INSTRUMENT

The following is a multiple choice test consisting of photographs of various combinations of the blocks which you have been shown. Each page of the test will have a photograph of a block with an arrow pointing toward the block. Your task is to imagine what the block would look like if you were directly behind the arrow looking at the block.

You may choose from the four smaller photographs or if you think none of the photographs represent what you would see, mark no. 5. Turn to item 0 on the first page. What would your choice be? (Answer - no. 4)

We will all take the test at the same rate. When I give the signal, turn to item number one. Then we will turn a page every 15 seconds. I will say the word "turn" when you are to go to the next item.

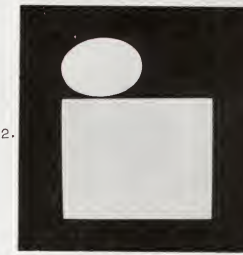
Thank you

W. P. Palow
Dept. of Sec. Ed.
Univ. of Fla.

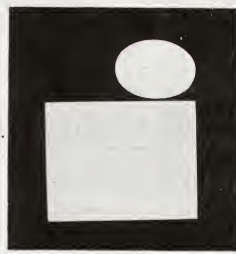
0

1.

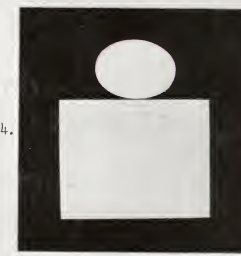
2.



3.

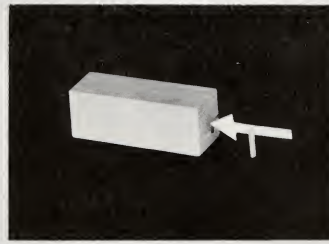


4.



5. None of these views is seen from the position of the arrow.

1



1.

2.

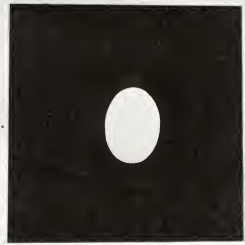
3.

4.

5. None of these views is seen from the position of the arrow.

2

1.



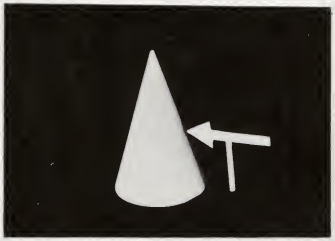
2.

3.

4.

5. None of these views is seen from the position of the arrow.

3



1.

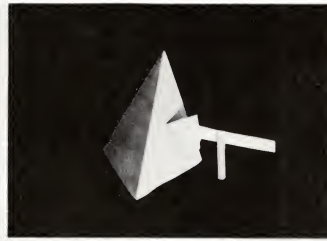
2.

3.

4.

5. None of these views is seen from the position of the arrow.

4

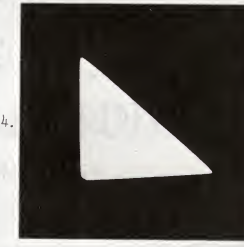


1.

2.

3.

4.

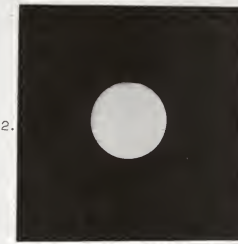


5. None of these views is seen from the position of the arrow.

5

1.

2.



3.

4.

5. None of these views is seen from the position of the arrow.

6

1.

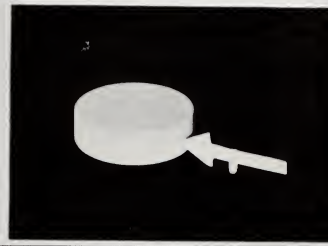
2.

3.

4.

5. None of these views is seen from the position of the arrow.

7

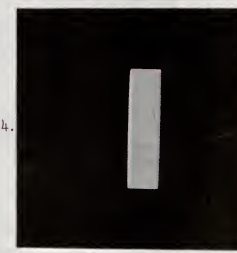


1.

2.

3.

4.



5. None of these views is seen from the position of the arrow.

8

1.

2.

3.

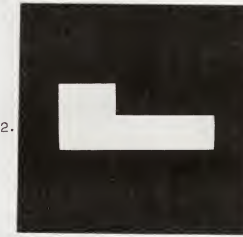
4.

5. None of these views is seen from the position of the arrow.

9

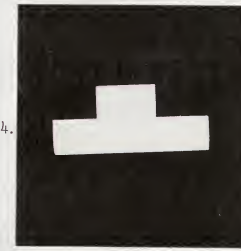
1.

2.



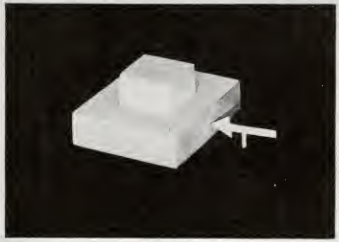
3.

4.



5. None of these views is seen from the position of the arrow.

10



1.

2.

3.

4.

5. None of these views is seen from the position of the arrow.

11

1.

2.

3.

4.

5. None of these views is seen from the position of the arrow.

12

1.

2.

3.

4.

5. None of these views is seen from the position of the arrow.

13

1.

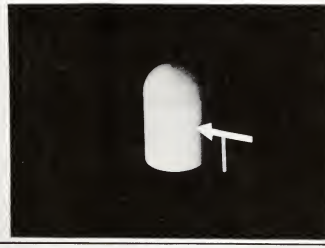
2.

3.

4.

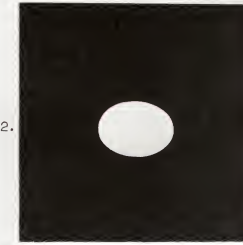
5. None of these views is seen from the position of the arrow.

14



1.

2.



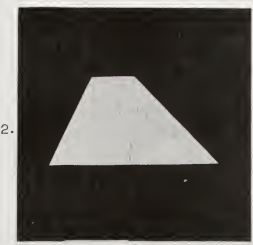
3.

4.

5. None of these views is seen from the position of the arrow.

15

1.



2.

3.

4.

5. None of these views is seen from the position of the arrow.

16

1.

2.

3.

4.

5. None of these views is seen from the position of the arrow.

17

1.

2.

3.

4.

5. None of these views is seen from the position of the arrow.

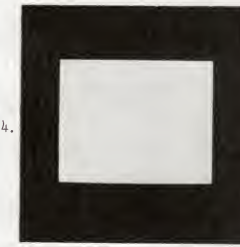
18

1.

2.

3.

4.



5. None of these views is seen from the position of the arrow.

19

1.

2.

3.

4.

5. None of these views is seen from the position of the arrow.

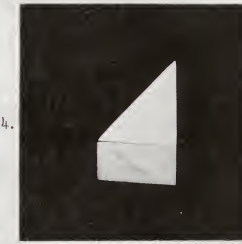
20

1.

2.

3.

4.



5. None of these views is seen from the position of the arrow.

APPENDIX B

RAW DATA

Each subject was assigned an identification number using the following convention. Subjects in grade 3 were given numbers in the 0 to 199 range; those in grade 4, numbers in the 200 to 399 range; grade 5, in the 400 to 599 range; grade 6, in the 600 to 799 range; grade 7, in the 800 to 999 range; grade 8, in the 1000 to 1199 range; grade 9, in the 1200 to 1399 range; grade 10, in the 1400 to 1599 range; grade 11, in the 1600 to 1799 range; and grade 12, in the 1800 to 1999 range.

The raw data are coded with 2 levels of sex, 11 levels of age, 3 levels of socio-economic groups, 3 levels of I. Q. scores and 10 levels of grade. Boys are coded with a 1, and girls are coded with a 2. The remaining categories are coded as outlined in the section entitled, "Coding Procedures," pages 38-40.

The column headed ORIG. lists the original score on the 20-item instrument for each subject. The column headed CORR. lists the corrected score for each subject after the rejected items were deleted from the original instrument to give a 13-item instrument. The columns headed ODD and EVEN are the odd and even scores, respectively, for each subject in the split-halves test of reliability.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
0001	1	8	1	2	3	6.	4.	3.	1.
0002	1	9	3	3	3	18.	13.	7.	6.
0003	2	8	3	3	3	11.	8.	5.	3.
0004	2	8	1	3	3	10.	7.	4.	3.
0005	2	8	3	2	3	7.	4.	3.	1.
0006	2	8	3	3	3	16.	13.	7.	6.
0007	1	8	1	3	3	12.	8.	4.	4.
0008	2	8	1	3	3	9.	7.	3.	4.
0009	2	8	2	3	3	10.	8.	4.	4.
0010	1	9	3	3	3	12.	8.	4.	4.
0011	2	9	3	3	3	12.	10.	5.	5.
0012	1	9	1	2	3	9.	8.	5.	3.
0013	1	8	1	3	3	10.	6.	4.	2.
0014	1	8	2	3	3	12.	9.	5.	4.
0015	1	8	3	2	3	8.	7.	3.	4.
0016	1	9	1	1	3	11.	5.	3.	2.
0017	2	8	1	3	3	12.	9.	4.	5.
0018	2	8	2	3	3	7.	4.	3.	1.
0019	1	8	3	3	3	14.	11.	7.	4.
0020	1	8	3	3	3	14.	11.	6.	5.
0021	1	9	1	2	3	3.	2.	1.	1.
0022	2	8	1	3	3	5.	2.	1.	1.
0023	1	9	3	3	3	7.	4.	2.	2.
0024	1	8	3	2	3	6.	4.	4.	0.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
0025	1	9	1	2	3	11.	7.	4.	3.
0026	2	8	1	2	3	10.	7.	4.	3.
0027	1	9	2	3	3	14.	10.	4.	6.
0028	1	9	1	2	3	4.	4.	3.	1.
0029	1	8	1	2	3	10.	8.	3.	5.
0030	1	8	1	2	3	13.	10.	5.	5.
0031	1	8	1	3	3	14.	12.	6.	6.
0032	1	8	1	2	3	14.	11.	6.	5.
0033	1	9	1	2	3	11.	6.	4.	2.
0034	1	8	2	2	3	6.	5.	3.	2.
0035	1	9	1	3	3	8.	5.	4.	1.
0036	1	8	1	2	3	7.	4.	2.	2.
0037	1	8	3	3	3	6.	4.	2.	2.
0038	1	8	2	2	3	13.	8.	5.	3.
0039	1	9	1	2	3	5.	4.	2.	2.
0040	1	9	1	3	3	7.	4.	2.	2.
0041	1	10	1	2	3	9.	5.	3.	2.
0042	1	9	2	3	3	11.	7.	5.	2.
0043	1	8	3	3	3	15.	11.	6.	5.
0044	2	9	1	1	3	8.	6.	2.	4.
0045	2	10	1	2	3	10.	4.	2.	2.
0046	2	8	2	3	3	6.	5.	3.	2.
0047	2	8	2	3	3	12.	8.	5.	3.
0048	2	9	1	2	3	7.	4.	3.	1.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
0049	2	8	1	3	3	12.	8.	4.	4.
0050	2	9	2	2	3	5.	4.	1.	3.
0051	2	9	3	2	3	14.	11.	6.	5.
0052	2	9	1	2	3	10.	6.	4.	2.
0053	2	8	2	3	3	16.	11.	5.	6.
0054	2	9	1	2	3	7.	5.	3.	2.
0055	2	9	1	2	3	16.	12.	7.	5.
0056	2	8	3	2	3	11.	9.	5.	4.
0057	2	8	2	3	3	7.	4.	2.	2.
0058	2	8	3	3	3	5.	3.	0.	3.
0059	2	8	3	3	3	11.	9.	4.	5.
0060	2	8	2	3	3	7.	4.	3.	1.
0061	2	9	2	3	3	9.	6.	3.	3.
0062	2	9	2	3	3	8.	5.	3.	2.
0063	2	8	1	3	3	4.	2.	2.	0.
0064	2	9	3	2	3	15.	11.	6.	5.
0065	2	8	2	3	3	12.	8.	4.	4.
0066	1	8	1	3	3	14.	10.	4.	6.
0067	1	9	1	3	3	8.	5.	3.	2.
0068	1	8	1	3	3	11.	7.	5.	2.
0069	1	11	1	1	3	7.	4.	3.	1.
0070	1	8	1	3	3	7.	5.	3.	2.
0071	1	8	2	2	3	5.	3.	2.	1.
0072	1	9	3	3	3	6.	4.	3.	1.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
0073	1	9	2	2	3	11.	8.	4.	4.
0074	1	9	1	2	3	12.	10.	4.	6.
0075	1	9	2	2	3	14.	9.	5.	4.
0076	1	9	1	2	3	7.	4.	3.	1.
0077	1	9	2	3	3	15.	11.	5.	6.
0078	2	8	2	2	3	7.	4.	2.	2.
0079	2	9	3	3	3	9.	6.	5.	1.
0080	1	8	3	2	3	18.	13.	7.	6.
0081	1	8	3	3	3	15.	12.	6.	6.
0082	1	8	1	3	3	10.	7.	3.	4.
0083	1	8	1	3	3	11.	9.	4.	5.
0084	2	10	1	2	3	6.	3.	1.	2.
0085	2	8	3	3	3	12.	8.	4.	4.
0086	2	9	1	3	3	7.	4.	2.	2.
0087	2	8	2	3	3	15.	13.	7.	6.
0088	2	8	2	3	3	10.	8.	4.	4.
0089	2	8	3	3	3	6.	4.	3.	1.
0090	2	8	3	3	3	9.	7.	5.	2.
0091	1	9	2	3	3	15.	13.	7.	6.
0092	1	10	3	3	3	15.	11.	7.	4.
0093	1	8	2	3	3	17.	13.	7.	6.
0094	1	9	1	3	3	15.	13.	7.	6.
0095	1	8	1	3	3	13.	9.	5.	4.
0096	2	8	2	3	3	13.	10.	5.	5.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
0097	1	8	3	3	3	8.	5.	3.	2.
0098	1	9	2	2	3	9.	6.	4.	2.
0099	1	10	1	2	3	5.	3.	1.	2.
0100	1	8	3	3	3	9.	7.	4.	3.
0101	1	8	1	3	3	15.	11.	7.	4.
0102	1	10	1	2	3	7.	5.	3.	2.
0103	1	9	2	2	3	9.	6.	3.	3.
0104	1	9	2	3	3	14.	10.	5.	5.
0105	1	9	2	3	3	15.	12.	6.	6.
0106	1	9	1	2	3	12.	7.	4.	3.
0107	1	8	3	2	3	14.	12.	7.	5.
0200	1	10	1	3	4	14.	12.	6.	6.
0201	2	10	3	1	4	2.	2.	1.	1.
0202	1	10	1	2	4	16.	12.	6.	6.
0203	2	10	1	3	4	14.	10.	5.	5.
0204	1	9	1	2	4	1.	1.	0.	1.
0205	1	9	3	3	4	18.	12.	7.	5.
0206	1	10	1	1	4	6.	3.	2.	1.
0207	1	9	3	2	4	8.	5.	3.	2.
0208	1	10	1	2	4	12.	10.	4.	6.
0209	1	9	1	3	4	18.	13.	7.	6.
0210	1	10	2	3	4	14.	11.	6.	5.
0211	1	10	2	2	4	10.	5.	2.	3.
0212	1	10	3	2	4	12.	8.	5.	3.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
0213	1	9	2	3	4	8.	7.	4.	3.
0214	1	9	3	3	4	13.	10.	5.	5.
0215	1	9	1	3	4	14.	11.	6.	5.
0216	1	10	2	2	4	8.	7.	4.	3.
0217	2	9	3	3	4	10.	8.	6.	2.
0218	2	9	3	2	4	2.	2.	1.	1.
0219	2	11	2	3	4	13.	11.	5.	6.
0220	2	10	1	1	4	12.	8.	3.	5.
0221	2	10	1	3	4	6.	5.	3.	2.
0222	2	10	2	2	4	7.	4.	2.	2.
0223	1	9	1	2	4	9.	6.	3.	3.
0224	2	10	3	3	4	8.	6.	2.	4.
0225	2	9	1	3	4	14.	11.	6.	5.
0226	1	9	3	2	4	18.	13.	7.	6.
0227	1	11	1	2	4	13.	9.	6.	3.
0228	2	10	1	2	4	12.	9.	4.	5.
0229	2	9	2	3	4	8.	6.	2.	4.
0230	2	10	3	3	4	18.	13.	7.	6.
0231	2	10	2	2	4	15.	11.	7.	4.
0232	2	9	3	3	4	14.	11.	6.	5.
0233	2	10	3	3	4	15.	12.	6.	6.
0234	2	10	3	3	4	11.	9.	4.	5.
0235	2	10	2	3	4	13.	10.	5.	5.
0236	1	9	1	1	4	10.	6.	3.	3.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
0237	2	9	1	3	4	9.	7.	4.	3.
0238	2	10	2	2	4	16.	11.	6.	5.
0239	1	10	3	2	4	17.	13.	7.	6.
0240	2	9	3	3	4	12.	10.	4.	6.
0241	1	10	1	3	4	16.	13.	7.	6.
0242	1	9	3	3	4	7.	4.	3.	1.
0243	1	10	1	2	4	4.	2.	2.	0.
0244	1	9	1	3	4	2.	1.	1.	0.
0245	2	9	1	3	4	14.	11.	5.	6.
0246	1	9	3	3	4	14.	12.	7.	5.
0247	2	9	2	3	4	13.	11.	6.	5.
0248	1	9	3	3	4	15.	13.	7.	6.
0249	1	10	3	3	4	2.	0.	0.	0.
0250	2	10	3	1	4	9.	6.	5.	1.
0251	1	10	1	2	4	16.	11.	5.	6.
0252	2	9	2	2	4	10.	8.	4.	4.
0253	1	9	3	3	4	10.	6.	4.	2.
0254	1	9	3	3	4	15.	12.	6.	6.
0255	1	10	1	2	4	18.	13.	7.	6.
0256	1	9	2	2	4	5.	5.	3.	2.
0257	1	10	2	2	4	2.	1.	0.	1.
0258	2	10	2	3	4	10.	7.	4.	3.
0259	1	9	2	3	4	13.	10.	5.	5.
0260	1	9	1	2	4	16.	13.	7.	6.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
0261	1	9	3	2	4	13.	10.	5.	5.
0262	2	10	3	3	4	10.	8.	4.	4.
0263	2	9	2	3	4	14.	12.	6.	6.
0264	2	9	3	3	4	8.	8.	4.	4.
0265	1	9	3	3	4	17.	13.	7.	6.
0266	2	9	3	3	4	16.	13.	7.	6.
0267	2	10	3	2	4	7.	5.	3.	2.
0268	1	10	3	2	4	6.	5.	3.	2.
0269	1	10	3	3	4	14.	10.	5.	5.
0270	2	10	2	2	4	6.	6.	3.	3.
0272	2	10	2	2	4	10.	6.	5.	1.
0273	1	10	1	2	4	6.	4.	3.	1.
0274	1	9	2	3	4	3.	1.	1.	0.
0275	1	10	3	2	4	19.	13.	7.	6.
0276	1	10	2	1	4	6.	5.	4.	1.
0277	1	9	1	3	4	12.	9.	6.	3.
0278	1	10	3	2	4	13.	9.	5.	4.
0279	1	10	2	2	4	13.	9.	5.	4.
0280	1	10	2	3	4	12.	9.	4.	5.
0281	1	9	2	2	4	7.	5.	4.	1.
0282	1	9	3	3	4	10.	8.	3.	5.
0283	1	9	1	2	4	13.	11.	5.	6.
0284	1	10	1	2	4	4.	3.	2.	1.
0285	1	10	1	2	4	10.	7.	4.	3.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
0286	1	9	3	3	4	15.	12.	7.	5.
0287	2	10	1	2	4	4.	4.	3.	1.
0288	2	9	1	2	4	6.	4.	1.	3.
0289	2	9	3	2	4	11.	7.	4.	3.
0290	2	9	2	3	4	15.	12.	6.	6.
0291	2	10	1	3	4	12.	9.	5.	4.
0292	1	9	2	2	4	6.	3.	3.	0.
0293	2	9	2	3	4	10.	7.	3.	4.
0294	2	10	2	2	4	8.	5.	3.	2.
0295	2	10	3	3	4	10.	7.	3.	4.
0296	2	9	2	2	4	17.	13.	7.	6.
0297	2	9	1	3	4	9.	7.	3.	4.
0400	2	10	2	3	5	15.	11.	6.	5.
0401	1	11	1	1	5	12.	8.	5.	3.
0402	1	11	1	2	5	17.	13.	7.	6.
0403	2	11	1	2	5	14.	11.	5.	6.
0404	2	11	3	1	5	13.	8.	4.	4.
0405	1	10	1	2	5	14.	10.	4.	6.
0406	2	11	1	2	5	9.	7.	3.	4.
0407	2	11	1	2	5	9.	9.	6.	3.
0408	1	10	1	2	5	8.	4.	3.	1.
0409	2	10	1	2	5	13.	11.	6.	5.
0410	2	11	1	2	5	12.	8.	3.	5.
0411	2	10	2	2	5	4.	2.	1.	1.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
0412	2	11	1	2	5	13.	10.	4.	6.
0413	1	10	1	2	5	6.	5.	3.	2.
0414	1	10	1	2	5	11.	9.	5.	4.
0415	1	10	1	3	5	9.	6.	4.	2.
0416	2	10	1	3	5	16.	12.	6.	6.
0417	1	10	1	3	5	16.	13.	7.	6.
0418	1	10	3	3	5	17.	13.	7.	6.
0419	2	10	1	3	5	8.	4.	2.	2.
0420	2	11	2	3	5	14.	11.	6.	5.
0421	1	10	1	2	5	13.	9.	5.	4.
0422	2	11	3	3	5	16.	12.	6.	6.
0423	2	11	1	3	5	13.	9.	5.	4.
0424	2	10	2	2	5	9.	6.	1.	5.
0425	1	11	1	2	5	16.	12.	6.	6.
0426	2	10	2	3	5	15.	12.	7.	5.
0427	1	11	3	2	5	11.	8.	3.	5.
0428	2	14	1	2	5	13.	10.	6.	4.
0429	2	11	2	3	5	11.	8.	5.	3.
0430	1	11	1	2	5	13.	10.	5.	5.
0431	1	11	3	3	5	14.	11.	6.	5.
0432	2	10	3	2	5	11.	9.	4.	5.
0433	1	10	1	3	5	10.	8.	4.	4.
0434	1	10	1	3	5	17.	13.	7.	6.
0435	2	12	1	2	5	14.	10.	7.	3.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
0436	1	10	1	2	5	15.	12.	6.	6.
0437	2	10	1	2	5	13.	10.	5.	5.
0438	1	13	1	2	5	9.	6.	3.	3.
0439	1	11	2	3	5	15.	11.	7.	4.
0440	1	11	1	2	5	7.	4.	1.	3.
0441	2	10	3	3	5	16.	10.	6.	4.
0442	2	11	1	2	5	14.	10.	5.	5.
0443	2	10	3	3	5	12.	9.	5.	4.
0444	1	10	1	3	5	17.	13.	7.	6.
0445	1	11	1	3	5	14.	11.	5.	6.
0446	1	11	3	2	5	6.	4.	1.	3.
0447	2	10	3	3	5	17.	13.	7.	6.
0448	2	11	3	3	5	13.	10.	6.	4.
0449	2	11	1	3	5	13.	11.	5.	6.
0450	2	11	3	3	5	14.	12.	7.	5.
0451	2	11	3	2	5	14.	10.	6.	4.
0452	1	11	1	2	5	16.	12.	7.	5.
0453	2	10	2	3	5	13.	9.	5.	4.
0454	2	10	1	2	5	16.	12.	6.	6.
0455	2	10	1	3	5	10.	9.	5.	4.
0456	1	10	1	3	5	13.	6.	3.	3.
0457	1	10	1	2	5	11.	8.	3.	5.
0458	2	10	1	3	5	12.	9.	4.	5.
0459	2	11	1	3	5	15.	12.	6.	6.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
0460	2	10	1	2	5	7.	5.	2.	3.
0461	1	13	1	3	5	16.	13.	7.	6.
0462	2	12	1	2	5	15.	12.	7.	5.
0463	2	10	3	3	5	13.	11.	6.	5.
0464	2	11	3	3	5	14.	11.	6.	5.
0465	2	10	1	3	5	9.	7.	4.	3.
0466	2	11	2	3	5	15.	12.	7.	5.
0467	1	10	2	2	5	11.	9.	5.	4.
0468	1	10	2	1	5	5.	4.	4.	0.
0469	1	11	1	2	5	11.	8.	6.	2.
0470	1	11	1	3	5	14.	12.	6.	6.
0471	2	11	1	3	5	10.	9.	6.	3.
0472	1	10	2	3	5	17.	13.	7.	6.
0473	1	11	1	2	5	18.	13.	7.	6.
0474	1	10	2	2	5	17.	13.	7.	6.
0475	1	10	2	2	5	18.	12.	6.	6.
0476	2	10	1	3	5	17.	12.	6.	6.
0477	2	10	1	3	5	10.	8.	4.	4.
0478	1	10	3	2	5	12.	9.	4.	5.
0479	2	10	1	3	5	11.	8.	4.	4.
0480	2	10	2	3	5	9.	6.	3.	3.
0481	1	11	1	2	5	17.	13.	7.	6.
0482	1	11	3	2	5	12.	10.	6.	4.
0483	1	10	1	3	5	17.	13.	7.	6.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
0484	2	11	1	3	5	14.	12.	6.	6.
0485	2	10	3	2	5	13.	11.	5.	6.
0486	1	11	1	3	5	12.	10.	5.	5.
0487	1	11	1	2	5	16.	12.	6.	6.
0488	2	10	1	3	5	14.	11.	6.	5.
0489	2	11	2	2	5	14.	10.	4.	6.
0490	2	11	1	2	5	10.	7.	2.	5.
0491	1	10	2	3	5	13.	10.	4.	6.
0492	2	10	1	3	5	7.	5.	3.	2.
0493	2	10	3	3	5	15.	12.	7.	5.
0494	1	11	2	2	5	15.	9.	6.	3.
0495	1	11	1	2	5	15.	13.	7.	6.
0496	2	10	2	3	5	14.	10.	5.	5.
0497	2	10	2	3	5	14.	10.	6.	4.
0498	2	10	2	3	5	8.	5.	4.	1.
0499	2	10	2	2	5	11.	9.	5.	4.
0500	1	11	1	2	5	14.	11.	5.	6.
0501	2	10	1	3	5	14.	11.	5.	6.
0502	2	11	2	2	5	15.	10.	6.	4.
0503	2	10	2	3	5	11.	8.	3.	5.
0504	2	10	2	3	5	12.	10.	5.	5.
0505	1	10	3	2	5	13.	11.	7.	4.
0506	1	11	2	2	5	17.	12.	6.	6.
0507	2	11	1	2	5	8.	5.	2.	3.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
0508	1	11	2	3	5	13.	11.	6.	5.
0509	2	10	2	3	5	13.	10.	4.	6.
0510	2	11	3	2	5	5.	4.	2.	2.
0511	2	10	2	3	5	7.	4.	2.	2.
0512	1	10	2	2	5	14.	10.	5.	5.
0513	2	10	1	2	5	15.	11.	6.	5.
0514	1	10	1	2	5	8.	5.	4.	1.
0515	2	10	2	2	5	15.	11.	6.	5.
0516	1	10	3	2	5	17.	13.	7.	6.
0517	2	10	1	2	5	8.	5.	2.	3.
0518	1	12	2	2	5	15.	13.	7.	6.
0600	1	12	1	2	6	13.	10.	5.	5.
0601	1	13	1	2	6	2.	1.	0.	1.
0602	1	12	1	3	6	13.	8.	4.	4.
0603	2	11	1	2	6	13.	9.	5.	4.
0604	2	12	1	2	6	11.	7.	4.	3.
0605	1	11	1	2	6	11.	7.	2.	5.
0606	2	12	1	2	6	6.	4.	3.	1.
0607	1	12	1	2	6	15.	12.	6.	6.
0608	1	13	1	2	6	17.	12.	6.	6.
0609	1	11	1	2	6	13.	10.	4.	6.
0610	2	12	1	2	6	14.	11.	5.	6.
0611	2	12	3	1	6	10.	8.	3.	5.
0612	1	11	1	2	6	9.	7.	5.	2.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
0613	2	11	1	3	6	13.	11.	5.	6.
0614	1	12	1	2	6	16.	13.	7.	6.
0615	2	11	3	3	6	15.	12.	7.	5.
0616	2	11	1	1	6	13.	8.	3.	5.
0617	2	12	1	2	6	11.	8.	5.	3.
0618	1	12	1	2	6	12.	9.	5.	4.
0619	1	12	1	2	6	8.	7.	4.	3.
0620	2	11	3	3	6	12.	10.	4.	6.
0621	1	11	1	2	6	14.	11.	5.	6.
0622	2	12	1	3	6	10.	8.	4.	4.
0623	2	12	1	2	6	13.	9.	4.	5.
0624	1	11	3	3	6	15.	13.	7.	6.
0625	2	11	1	3	6	15.	11.	6.	5.
0626	1	12	1	2	6	16.	13.	7.	6.
0627	2	11	1	3	6	9.	6.	3.	3.
0628	1	12	3	2	6	16.	13.	7.	6.
0629	1	12	1	2	6	16.	13.	7.	6.
0630	2	11	1	3	6	12.	9.	4.	5.
0631	2	12	3	3	6	12.	8.	5.	3.
0632	1	11	3	3	6	12.	9.	5.	4.
0633	1	11	2	3	6	17.	13.	7.	6.
0634	1	11	2	3	6	17.	13.	7.	6.
0635	1	12	3	2	6	15.	12.	6.	6.
0636	1	12	2	3	6	17.	12.	6.	6.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
0637	2	11	2	3	6	14.	10.	7.	3.
0638	2	12	3	3	6	15.	12.	6.	6.
0639	2	11	2	3	6	14.	11.	6.	5.
0640	2	12	3	2	6	13.	10.	4.	6.
0641	2	11	2	3	6	15.	11.	6.	5.
0642	1	10	1	3	6	12.	10.	5.	5.
0643	1	12	1	2	6	8.	6.	2.	4.
0644	1	11	2	3	6	15.	10.	6.	4.
0645	2	11	2	3	6	14.	10.	5.	5.
0647	2	11	2	3	6	16.	13.	7.	6.
0648	2	11	1	3	6	17.	13.	7.	6.
0649	1	11	3	2	6	16.	13.	7.	6.
0650	2	11	2	3	6	17.	13.	7.	6.
0651	1	11	3	3	6	16.	13.	7.	6.
0652	2	11	1	2	6	16.	13.	7.	6.
0653	1	11	1	3	6	9.	7.	5.	2.
0654	2	11	3	3	6	15.	12.	6.	6.
0655	1	11	3	3	6	12.	10.	5.	5.
0656	1	11	3	3	6	16.	12.	7.	5.
0658	2	11	2	3	6	11.	9.	4.	5.
0659	1	11	3	2	6	14.	9.	5.	4.
0660	2	10	2	3	6	11.	7.	4.	3.
0661	1	11	3	3	6	17.	13.	7.	6.
0662	1	11	1	2	6	10.	7.	5.	2.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
0663	1	12	1	3	6	13.	11.	6.	5.
0664	1	11	3	3	6	12.	10.	5.	5.
0665	2	11	3	3	6	17.	13.	7.	6.
0666	1	11	2	3	6	17.	13.	7.	6.
0667	2	11	3	3	6	11.	7.	5.	2.
0668	1	13	1	2	6	8.	8.	4.	4.
0669	2	11	1	2	6	8.	5.	3.	2.
0670	2	12	2	2	6	15.	12.	7.	5.
0671	2	11	1	3	6	3.	1.	0.	1.
0672	2	11	2	3	6	12.	9.	4.	5.
0673	2	11	1	3	6	14.	12.	7.	5.
0674	2	12	1	2	6	4.	0.	0.	0.
0675	2	11	2	2	6	7.	4.	1.	3.
0676	2	12	1	2	6	13.	10.	6.	4.
0677	2	11	3	3	6	17.	13.	7.	6.
0678	1	11	2	3	6	10.	7.	5.	2.
0679	1	11	3	2	6	14.	10.	4.	6.
0680	1	12	3	2	6	12.	8.	5.	3.
0681	1	12	3	2	6	16.	13.	7.	6.
0682	2	11	2	3	6	13.	11.	6.	5.
0683	2	11	2	2	6	9.	6.	3.	3.
0684	1	11	3	3	6	10.	6.	5.	1.
0685	1	13	1	1	6	15.	12.	6.	6.
0686	1	11	3	3	6	16.	12.	7.	5.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
0687	1	11	1	3	6	17.	13.	7.	6.
0688	1	12	2	2	6	16.	12.	6.	6.
0689	1	12	1	3	6	16.	11.	5.	6.
0690	1	11	1	2	6	15.	12.	7.	5.
0691	1	11	1	3	6	10.	6.	4.	2.
0692	1	11	1	3	6	14.	11.	7.	4.
0693	1	11	1	3	6	8.	6.	3.	3.
0694	1	12	1	2	6	8.	5.	3.	2.
0695	2	12	2	3	6	15.	11.	5.	6.
0696	2	12	2	2	6	14.	10.	5.	5.
0697	1	12	2	3	6	18.	13.	7.	6.
0698	1	12	2	2	6	15.	13.	7.	6.
0699	2	11	2	3	6	15.	13.	7.	6.
0700	1	12	3	2	6	14.	12.	6.	6.
0701	1	13	1	1	6	2.	1.	0.	1.
0702	2	11	1	2	6	14.	12.	6.	6.
0703	1	11	3	3	6	16.	13.	7.	6.
0704	2	11	3	2	6	11.	9.	5.	4.
0705	1	11	2	3	6	15.	12.	6.	6.
0706	2	11	1	2	6	13.	10.	5.	5.
0707	1	12	1	3	6	16.	12.	6.	6.
0708	2	12	3	2	6	16.	11.	6.	5.
0709	2	11	2	2	6	17.	12.	6.	6.
0710	1	12	3	3	6	15.	13.	7.	6.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
0711	1	13	1	2	6	15.	11.	6.	5.
0712	2	11	1	2	6	12.	9.	5.	4.
0713	2	11	3	3	6	12.	10.	6.	4.
0714	1	12	1	2	6	10.	7.	4.	3.
0715	2	12	1	2	6	16.	13.	7.	6.
0800	1	13	2	2	7	17.	12.	7.	5.
0801	1	13	1	2	7	13.	10.	6.	4.
0802	2	12	2	3	7	17.	13.	7.	6.
0803	2	13	1	3	7	15.	12.	6.	6.
0804	2	12	2	3	7	12.	10.	6.	4.
0805	1	13	1	2	7	8.	7.	4.	3.
0806	1	12	3	2	7	15.	11.	7.	4.
0807	2	13	1	2	7	14.	11.	6.	5.
0808	2	12	3	3	7	14.	10.	4.	6.
0809	2	13	2	2	7	13.	11.	6.	5.
0810	2	13	1	3	7	16.	12.	6.	6.
0811	2	12	1	2	7	15.	10.	6.	4.
0812	2	12	1	3	7	14.	10.	4.	6.
0813	1	13	1	1	7	15.	12.	7.	5.
0814	1	12	1	2	7	16.	12.	6.	6.
0815	1	12	1	2	7	14.	12.	6.	6.
0816	2	12	1	2	7	13.	10.	5.	5.
0817	2	12	2	2	7	12.	9.	5.	4.
0818	2	12	2	3	7	14.	11.	6.	5.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
0819	2	13	3	2	7	11.	6.	2.	4.
0820	2	12	1	2	7	12.	9.	4.	5.
0821	2	12	2	3	7	16.	13.	7.	6.
0822	1	13	1	1	7	15.	12.	6.	6.
0823	1	13	1	2	7	17.	13.	7.	6.
0824	1	12	1	3	7	8.	4.	2.	2.
0825	1	12	1	3	7	3.	2.	1.	1.
0826	1	13	1	2	7	15.	12.	6.	6.
0827	1	12	1	3	7	14.	12.	6.	6.
0828	1	13	2	2	7	16.	12.	6.	6.
0829	1	13	3	2	7	12.	8.	4.	4.
0830	1	12	1	3	7	16.	13.	7.	6.
0831	2	12	3	3	7	13.	10.	4.	6.
0832	2	13	1	3	7	13.	11.	5.	6.
0833	2	13	3	3	7	17.	13.	7.	6.
0834	2	13	2	3	7	14.	11.	6.	5.
0835	2	13	1	2	7	9.	6.	2.	4.
0836	1	14	2	1	7	10.	8.	3.	5.
0837	1	13	2	1	7	17.	11.	6.	5.
0838	1	13	1	2	7	9.	7.	3.	4.
0839	1	13	2	3	7	15.	11.	5.	6.
0840	2	12	1	3	7	14.	11.	5.	6.
0841	1	13	1	3	7	17.	13.	7.	6.
0842	1	12	1	3	7	16.	13.	7.	6.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
0843	2	13	1	2	7	17.	12.	6.	6.
0844	2	13	1	1	7	5.	3.	2.	1.
0845	1	13	1	2	7	16.	12.	7.	5.
0846	2	13	1	2	7	13.	11.	6.	5.
0847	2	12	2	2	7	13.	11.	7.	4.
0848	2	13	3	3	7	15.	11.	5.	6.
0849	1	13	3	2	7	14.	11.	6.	5.
0850	1	12	2	3	7	15.	12.	7.	5.
0851	2	12	1	2	7	16.	13.	7.	6.
0852	1	12	2	3	7	15.	12.	6.	6.
0853	1	12	1	3	7	15.	11.	5.	6.
0854	1	12	3	2	7	15.	12.	7.	5.
0855	2	13	1	2	7	18.	13.	7.	6.
0856	2	12	2	2	7	14.	9.	5.	4.
0857	2	12	1	2	7	15.	11.	6.	5.
0858	1	13	3	2	7	15.	11.	5.	6.
0859	1	12	1	3	7	17.	13.	7.	6.
0860	1	14	1	1	7	4.	1.	1.	0.
0861	2	12	1	2	7	14.	12.	6.	6.
0862	2	12	3	3	7	14.	10.	4.	6.
0863	2	12	1	2	7	15.	12.	6.	6.
0864	2	12	1	3	7	18.	13.	7.	6.
0865	1	13	1	2	7	12.	7.	4.	3.
0866	1	12	2	2	7	18.	13.	7.	6.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
0867	2	13	3	2	7	10.	7.	4.	3.
0868	2	12	2	3	7	16.	13.	7.	6.
0869	2	13	2	2	7	15.	11.	6.	5.
0870	2	12	1	2	7	14.	11.	7.	4.
0871	2	12	3	3	7	16.	13.	7.	6.
0872	1	12	1	3	7	18.	13.	7.	6.
0873	1	13	2	2	7	15.	12.	6.	6.
0874	1	12	3	3	7	13.	11.	6.	5.
0875	2	13	1	2	7	13.	8.	4.	4.
0876	2	13	1	1	7	9.	7.	5.	2.
0877	2	13	2	3	7	12.	9.	5.	4.
0878	2	13	2	2	7	15.	10.	4.	6.
0879	1	12	2	3	7	16.	13.	7.	6.
0880	1	13	3	3	7	10.	7.	4.	3.
0881	1	14	1	1	7	3.	2.	0.	2.
0882	1	13	1	3	7	16.	11.	6.	5.
0883	1	13	3	2	7	9.	8.	5.	3.
0884	1	14	1	2	7	14.	11.	5.	6.
0885	1	12	1	3	7	17.	13.	7.	6.
0886	2	13	1	3	7	15.	12.	6.	6.
0887	2	13	3	2	7	16.	12.	7.	5.
0888	2	12	3	3	7	16.	13.	7.	6.
0889	2	13	1	2	7	16.	11.	6.	5.
0890	2	12	3	3	7	16.	12.	7.	5.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
0891	2	12	2	2	7	15.	11.	5.	6.
0892	1	14	2	2	7	7.	6.	3.	3.
0893	1	13	1	2	7	9.	9.	5.	4.
0894	1	14	1	1	7	13.	11.	6.	5.
0895	1	12	3	3	7	13.	9.	5.	4.
0896	1	13	1	2	7	16.	13.	7.	6.
0897	2	13	2	2	7	18.	13.	7.	6.
0898	2	12	2	2	7	16.	12.	6.	6.
0899	2	13	2	2	7	15.	12.	6.	6.
0900	2	13	2	3	7	15.	12.	6.	6.
0901	2	13	1	3	7	15.	13.	7.	6.
1000	2	14	3	2	8	16.	13.	7.	6.
1001	2	14	1	2	8	17.	13.	7.	6.
1002	1	13	3	3	8	15.	12.	6.	6.
1003	1	13	1	2	8	17.	12.	7.	5.
1004	1	14	1	2	8	11.	8.	5.	3.
1005	2	14	1	3	8	15.	11.	7.	4.
1006	2	13	2	2	8	15.	12.	6.	6.
1007	2	14	2	2	8	15.	11.	5.	6.
1008	2	13	3	3	8	17.	13.	7.	6.
1009	2	14	1	2	8	13.	10.	5.	5.
1010	1	13	2	3	8	17.	13.	7.	6.
1011	1	13	1	3	8	14.	11.	5.	6.
1012	1	13	3	2	8	17.	13.	7.	6.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
1013	1	13	3	3	8	15.	11.	7.	4.
1014	2	14	3	3	8	7.	5.	3.	2.
1015	2	13	1	2	8	16.	13.	7.	6.
1016	2	14	1	2	8	18.	13.	7.	6.
1017	2	14	3	3	8	17.	12.	7.	5.
1018	2	14	1	2	8	14.	11.	6.	5.
1019	1	14	1	2	8	15.	12.	7.	5.
1020	1	14	1	2	8	15.	11.	7.	4.
1021	1	13	1	2	8	13.	11.	6.	5.
1022	1	14	3	3	8	14.	11.	5.	6.
1023	2	13	1	3	8	15.	13.	7.	6.
1024	1	13	1	2	8	16.	13.	7.	6.
1025	1	14	2	2	8	18.	12.	7.	5.
1026	1	14	1	2	8	16.	13.	7.	6.
1027	1	14	2	2	8	17.	13.	7.	6.
1028	1	14	2	2	8	14.	11.	6.	5.
1029	2	13	3	3	8	15.	13.	7.	6.
1030	2	13	3	3	8	14.	11.	7.	4.
1031	2	14	1	1	8	16.	12.	7.	5.
1032	2	13	1	2	8	14.	10.	5.	5.
1033	2	14	2	2	8	9.	6.	5.	1.
1034	2	14	1	2	8	18.	13.	7.	6.
1035	1	15	1	2	8	16.	12.	6.	6.
1036	1	15	3	1	8	10.	8.	4.	4.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
1037	1	14	3	2	8	14.	11.	6.	5.
1038	2	13	1	3	8	13.	11.	6.	5.
1039	2	13	2	3	8	16.	12.	7.	5.
1040	2	13	1	3	8	16.	12.	6.	6.
1041	2	13	1	2	8	10.	8.	4.	4.
1042	1	14	1	2	8	19.	12.	7.	5.
1043	1	14	3	3	8	16.	13.	7.	6.
1044	1	13	2	3	8	17.	13.	7.	6.
1045	1	15	1	1	8	12.	10.	5.	5.
1046	1	13	3	3	8	16.	12.	6.	6.
1047	2	14	3	2	8	14.	11.	5.	6.
1048	2	14	1	2	8	15.	12.	6.	6.
1049	2	13	3	2	8	16.	12.	6.	6.
1050	2	14	3	3	8	7.	6.	4.	2.
1051	2	15	1	2	8	7.	5.	3.	2.
1052	1	14	1	1	8	9.	5.	3.	2.
1053	1	14	1	2	8	15.	12.	7.	5.
1054	1	14	2	2	8	13.	7.	4.	3.
1055	1	14	2	2	8	16.	12.	6.	6.
1056	1	14	2	3	8	15.	12.	7.	5.
1057	1	13	3	3	8	15.	11.	6.	5.
1058	1	14	2	2	8	11.	9.	5.	4.
1059	2	14	2	2	8	16.	13.	7.	6.
1060	2	14	1	2	8	15.	11.	5.	6.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
1061	2	13	1	3	8	13.	11.	5.	6.
1062	2	13	2	2	8	15.	12.	7.	5.
1063	2	14	1	2	8	4.	3.	3.	0.
1064	2	14	1	2	8	16.	12.	6.	6.
1065	1	15	1	3	8	14.	11.	6.	5.
1066	1	13	1	3	8	17.	12.	7.	5.
1067	1	13	3	3	8	16.	13.	7.	6.
1068	2	13	2	2	8	16.	12.	7.	5.
1069	2	14	1	2	8	8.	7.	4.	3.
1070	2	13	3	3	8	14.	10.	5.	5.
1071	1	13	1	3	8	15.	12.	7.	5.
1072	1	14	2	2	8	16.	13.	7.	6.
1073	1	13	3	3	8	13.	11.	5.	6.
1074	1	13	2	2	8	15.	12.	7.	5.
1075	2	13	1	2	8	15.	10.	5.	5.
1076	2	14	1	2	8	12.	7.	3.	4.
1077	2	14	1	3	8	14.	9.	4.	5.
1078	2	13	2	3	8	14.	12.	7.	5.
1079	1	13	3	3	8	17.	13.	7.	6.
1080	1	14	2	3	8	18.	13.	7.	6.
1081	1	13	3	3	8	17.	13.	7.	6.
1082	1	14	2	2	8	17.	13.	7.	6.
1083	2	14	1	3	8	16.	13.	7.	6.
1084	2	14	1	2	8	13.	10.	6.	4.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
1085	2	13	3	3	8	14.	12.	6.	6.
1086	2	14	1	3	8	17.	13.	7.	6.
1087	2	13	3	2	8	16.	12.	6.	6.
1088	2	14	1	2	8	10.	5.	4.	1.
1089	2	13	2	3	8	13.	10.	4.	6.
1090	1	13	1	2	8	15.	12.	7.	5.
1091	2	13	3	2	8	10.	6.	3.	3.
1092	2	13	1	3	8	16.	12.	7.	5.
1093	1	13	1	2	8	13.	8.	4.	4.
1094	1	14	1	3	8	15.	11.	6.	5.
1095	1	13	1	2	8	16.	12.	6.	6.
1096	1	14	3	2	8	17.	13.	7.	6.
1097	2	14	3	2	8	10.	8.	4.	4.
1098	2	14	1	2	8	15.	11.	5.	6.
1099	2	14	1	2	8	11.	8.	4.	4.
1100	2	14	1	3	8	16.	13.	7.	6.
1101	1	13	1	3	8	16.	12.	7.	5.
1102	1	13	2	3	8	9.	6.	4.	2.
1103	2	14	1	2	8	12.	10.	5.	5.
1104	1	14	1	2	8	17.	12.	7.	5.
1105	2	14	1	1	8	12.	9.	6.	3.
1106	2	13	1	3	8	14.	12.	6.	6.
1107	2	13	1	3	8	14.	10.	4.	6.
1108	2	14	1	2	8	18.	13.	7.	6.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
1109	2	13	1	3	8	14.	10.	6.	4.
1110	1	15	1	2	8	17.	13.	7.	6.
1200	1	15	2	3	9	16.	12.	6.	6.
1201	1	14	2	3	9	14.	11.	6.	5.
1202	1	15	2	2	9	10.	6.	3.	3.
1203	1	15	1	2	9	15.	12.	7.	5.
1204	2	15	1	2	9	14.	12.	6.	6.
1205	2	14	2	3	9	18.	13.	7.	6.
1206	2	14	1	2	9	19.	13.	7.	6.
1207	2	14	1	2	9	18.	13.	7.	6.
1208	2	14	2	3	9	13.	11.	5.	6.
1209	1	14	2	3	9	18.	13.	7.	6.
1211	1	15	2	2	9	16.	9.	5.	4.
1212	1	14	1	2	9	18.	13.	7.	6.
1213	1	14	2	3	9	16.	11.	7.	4.
1214	2	14	2	3	9	14.	11.	6.	5.
1215	2	14	2	2	9	16.	11.	6.	5.
1216	2	16	2	2	9	14.	11.	5.	6.
1217	2	15	1	2	9	13.	9.	5.	4.
1218	1	15	1	2	9	18.	13.	7.	6.
1219	2	15	1	2	9	14.	11.	6.	5.
1220	2	15	1	2	9	16.	13.	7.	6.
1221	2	14	3	3	9	15.	13.	7.	6.
1222	2	15	1	2	9	13.	10.	5.	5.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
1223	2	16	1	2	9	17.	13.	7.	6.
1224	1	14	2	3	9	16.	12.	6.	6.
1225	1	14	1	2	9	17.	13.	7.	6.
1226	2	14	1	2	9	17.	13.	7.	6.
1227	2	15	1	2	9	10.	6.	5.	1.
1228	2	14	1	2	9	12.	9.	5.	4.
1229	2	15	2	2	9	16.	11.	7.	4.
1230	2	15	1	3	9	16.	11.	6.	5.
1231	1	14	2	2	9	14.	11.	6.	5.
1232	1	14	1	2	9	17.	13.	7.	6.
1233	1	15	2	3	9	14.	11.	5.	6.
1234	1	14	1	2	9	15.	12.	7.	5.
1235	2	14	1	2	9	15.	13.	7.	6.
1236	2	14	2	2	9	18.	13.	7.	6.
1237	2	14	1	2	9	11.	8.	5.	3.
1238	2	14	1	3	9	16.	13.	7.	6.
1239	2	15	1	3	9	16.	11.	6.	5.
1240	1	14	3	2	9	11.	8.	4.	4.
1241	1	14	1	2	9	14.	12.	6.	6.
1242	1	14	2	3	9	16.	13.	7.	6.
1243	1	14	3	3	9	17.	12.	7.	5.
1244	2	14	2	3	9	17.	13.	7.	6.
1245	2	14	1	3	9	11.	7.	5.	2.
1246	2	14	3	3	9	16.	11.	6.	5.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
1247	2	14	2	3	9	10.	9.	4.	5.
1248	2	14	1	2	9	16.	13.	7.	6.
1249	2	15	2	3	9	12.	9.	5.	4.
1250	2	15	2	3	9	11.	8.	4.	4.
1251	2	14	1	3	9	12.	10.	5.	5.
1252	2	14	2	3	9	15.	13.	7.	6.
1253	2	15	1	2	9	19.	13.	7.	6.
1254	1	14	1	3	9	12.	10.	6.	4.
1255	1	14	1	2	9	16.	13.	7.	6.
1256	1	15	1	2	9	8.	4.	3.	1.
1257	2	14	1	3	9	18.	12.	6.	6.
1258	2	14	2	2	9	14.	11.	6.	5.
1259	2	15	1	2	9	18.	12.	7.	5.
1260	2	15	2	2	9	17.	12.	6.	6.
1261	1	14	3	3	9	16.	13.	7.	6.
1262	1	15	1	2	9	16.	11.	5.	6.
1263	1	14	2	3	9	16.	12.	7.	5.
1264	1	15	3	2	9	14.	11.	6.	5.
1265	2	15	1	2	9	11.	8.	3.	5.
1266	2	15	2	3	9	18.	13.	7.	6.
1267	2	14	1	2	9	16.	12.	7.	5.
1268	2	14	1	3	9	17.	12.	6.	6.
1269	1	14	1	2	9	14.	10.	4.	6.
1270	1	15	2	2	9	15.	11.	6.	5.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
1271	1	15	3	3	9	17.	11.	6.	5.
1272	1	14	3	2	9	19.	13.	7.	6.
1273	1	14	1	2	9	15.	11.	5.	6.
1274	2	14	2	2	9	12.	10.	5.	5.
1275	1	15	1	3	9	13.	10.	6.	4.
1276	1	15	1	3	9	17.	13.	7.	6.
1277	1	16	3	2	9	9.	6.	4.	2.
1278	1	14	3	3	9	14.	12.	7.	5.
1279	1	14	2	3	9	18.	13.	7.	6.
1280	2	14	3	3	9	14.	10.	5.	5.
1281	2	15	1	3	9	17.	12.	7.	5.
1282	2	14	1	3	9	14.	11.	5.	6.
1283	2	14	1	3	9	17.	13.	7.	6.
1284	2	15	1	3	9	16.	12.	7.	5.
1285	1	15	1	3	9	16.	13.	7.	6.
1286	1	14	3	3	9	14.	11.	6.	5.
1287	1	14	1	3	9	17.	13.	7.	6.
1288	2	14	2	3	9	17.	13.	7.	6.
1289	2	14	1	3	9	18.	13.	7.	6.
1290	2	14	1	3	9	16.	12.	6.	6.
1291	2	14	3	3	9	15.	12.	7.	5.
1292	2	14	1	3	9	16.	11.	6.	5.
1293	2	14	2	2	9	14.	10.	5.	5.
1294	1	16	1	2	9	17.	13.	7.	6.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
1295	1	14	3	3	9	12.	10.	6.	4.
1296	1	14	2	2	9	15.	11.	7.	4.
1297	1	15	1	3	9	18.	13.	7.	6.
1298	1	15	2	2	9	13.	10.	5.	5.
1299	1	16	1	1	9	16.	13.	7.	6.
1300	1	15	1	2	9	18.	12.	6.	6.
1400	1	15	1	3	10	15.	12.	7.	5.
1401	1	16	1	2	10	18.	13.	7.	6.
1402	1	16	1	2	10	17.	13.	7.	6.
1403	2	15	1	3	10	17.	13.	7.	6.
1404	1	15	1	3	10	14.	12.	6.	6.
1405	1	15	3	3	10	17.	13.	7.	6.
1406	2	15	2	2	10	12.	10.	5.	5.
1407	1	15	1	2	10	11.	7.	4.	3.
1408	1	15	3	2	10	14.	10.	4.	6.
1409	1	17	1	1	10	18.	12.	6.	6.
1410	1	16	2	3	10	17.	13.	7.	6.
1411	2	16	2	2	10	16.	12.	7.	5.
1412	1	16	1	2	10	15.	12.	6.	6.
1413	2	16	1	2	10	14.	10.	4.	6.
1414	2	16	1	2	10	16.	13.	7.	6.
1415	1	16	1	2	10	15.	12.	7.	5.
1416	1	15	3	2	10	16.	13.	7.	6.
1417	1	15	1	2	10	16.	13.	7.	6.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
1418	1	16	2	2	10	12.	9.	4.	5.
1419	2	16	2	2	10	16.	11.	7.	4.
1420	1	16	1	2	10	10.	6.	5.	1.
1421	1	15	1	2	10	17.	13.	7.	6.
1422	2	15	1	2	10	16.	12.	7.	5.
1423	1	15	1	3	10	16.	13.	7.	6.
1424	1	15	1	3	10	17.	13.	7.	6.
1425	1	15	2	3	10	12.	8.	5.	3.
1426	1	15	1	2	10	18.	13.	7.	6.
1427	1	15	1	2	10	16.	12.	6.	6.
1428	1	16	1	2	10	17.	13.	7.	6.
1429	2	16	1	3	10	16.	12.	7.	5.
1430	1	15	2	2	10	14.	12.	7.	5.
1431	1	15	2	3	10	17.	12.	6.	6.
1432	1	15	2	2	10	15.	11.	6.	5.
1433	1	16	3	2	10	18.	13.	7.	6.
1434	1	15	2	2	10	15.	13.	7.	6.
1435	1	16	1	3	10	17.	13.	7.	6.
1436	1	16	1	1	10	14.	10.	4.	6.
1437	1	16	2	3	10	11.	7.	5.	2.
1439	2	15	3	2	10	15.	11.	5.	6.
1440	1	15	2	3	10	17.	13.	7.	6.
1441	1	15	1	3	10	15.	12.	7.	5.
1442	1	15	2	3	10	17.	13.	7.	6.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
1443	2	15	1	2	10	15.	12.	6.	6.
1444	2	15	3	3	10	17.	13.	7.	6.
1445	1	17	3	1	10	15.	11.	5.	6.
1446	1	16	2	3	10	17.	13.	7.	6.
1447	2	16	1	2	10	17.	13.	7.	6.
1448	1	15	1	3	10	17.	13.	7.	6.
1449	1	16	2	2	10	18.	13.	7.	6.
1450	1	16	3	2	10	15.	12.	7.	5.
1451	2	16	1	2	10	13.	11.	6.	5.
1452	2	15	3	3	10	13.	10.	5.	5.
1453	2	16	1	2	10	14.	11.	6.	5.
1454	1	15	2	2	10	11.	9.	5.	4.
1455	1	15	2	3	10	16.	11.	7.	4.
1456	1	16	2	2	10	18.	13.	7.	6.
1457	1	15	1	2	10	16.	11.	7.	4.
1458	1	16	1	1	10	16.	11.	6.	5.
1459	2	15	1	2	10	16.	13.	7.	6.
1460	2	18	1	1	10	16.	13.	7.	6.
1461	2	15	1	2	10	14.	10.	6.	4.
1462	2	16	3	3	10	15.	11.	6.	5.
1463	2	16	3	3	10	19.	13.	7.	6.
1464	1	16	2	2	10	17.	12.	7.	5.
1465	1	15	2	3	10	18.	13.	7.	6.
1466	1	16	1	3	10	15.	12.	6.	6.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
1467	1	16	2	3	10	15.	11.	7.	4.
1468	1	16	1	2	10	15.	12.	7.	5.
1469	2	16	1	2	10	14.	10.	5.	5.
1470	1	15	3	3	10	16.	12.	7.	5.
1471	1	16	2	2	10	11.	7.	4.	3.
1472	1	15	1	3	10	12.	10.	6.	4.
1473	1	17	1	2	10	14.	12.	6.	6.
1474	1	17	2	2	10	16.	13.	7.	6.
1475	1	15	1	2	10	14.	9.	4.	5.
1476	2	15	2	3	10	14.	12.	7.	5.
1477	1	15	1	3	10	18.	13.	7.	6.
1478	1	15	1	2	10	18.	13.	7.	6.
1479	1	15	1	2	10	16.	12.	7.	5.
1480	1	15	2	3	10	10.	8.	5.	3.
1481	2	15	1	2	10	15.	11.	7.	4.
1482	2	15	1	2	10	17.	13.	7.	6.
1483	1	16	1	3	10	14.	10.	6.	4.
1484	1	16	1	1	10	10.	8.	4.	4.
1485	1	17	1	3	10	17.	12.	7.	5.
1486	2	16	1	2	10	13.	10.	6.	4.
1487	1	15	1	3	10	16.	13.	7.	6.
1488	1	15	3	2	10	11.	7.	4.	3.
1489	1	15	1	3	10	17.	12.	6.	6.
1490	1	15	3	2	10	14.	12.	6.	6.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
1491	2	16	1	2	10	11.	7.	5.	2.
1492	1	15	3	2	10	14.	11.	6.	5.
1493	1	16	3	2	10	17.	13.	7.	6.
1494	1	15	3	2	10	16.	9.	6.	3.
1495	1	15	1	3	10	17.	13.	7.	6.
1496	1	15	1	3	10	18.	12.	7.	5.
1497	1	15	3	3	10	14.	12.	6.	6.
1498	1	15	2	3	10	17.	13.	7.	6.
1499	2	15	3	3	10	13.	11.	7.	4.
1500	2	15	1	3	10	14.	11.	5.	6.
1501	1	17	1	1	10	16.	12.	6.	6.
1502	1	16	1	1	10	15.	12.	7.	5.
1503	1	15	3	2	10	17.	12.	6.	6.
1504	2	15	1	2	10	16.	13.	7.	6.
1505	2	15	2	3	10	12.	10.	4.	6.
1506	2	15	1	2	10	8.	6.	4.	2.
1507	2	16	1	3	10	13.	7.	5.	2.
1600	1	16	3	2	11	16.	12.	6.	6.
1601	1	19	1	2	11	17.	13.	7.	6.
1602	2	17	1	2	11	17.	13.	7.	6.
1603	2	16	1	3	11	11.	8.	3.	5.
1604	2	17	2	3	11	16.	13.	7.	6.
1605	2	16	1	2	11	14.	12.	6.	6.
1606	1	16	2	3	11	18.	13.	7.	6.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
1607	1	17	2	2	11	15.	12.	6.	6.
1608	2	16	2	3	11	16.	12.	7.	5.
1609	2	16	1	3	11	16.	13.	7.	6.
1610	2	16	3	3	11	17.	13.	7.	6.
1611	1	17	2	3	11	16.	11.	5.	6.
1612	1	17	2	2	11	15.	12.	7.	5.
1613	1	17	2	3	11	16.	12.	7.	5.
1614	1	16	2	3	11	14.	11.	6.	5.
1615	1	17	1	2	11	19.	13.	7.	6.
1616	1	17	1	3	11	16.	12.	6.	6.
1617	1	17	1	2	11	18.	13.	7.	6.
1618	2	16	3	3	11	15.	13.	7.	6.
1619	1	16	1	1	11	13.	8.	5.	3.
1620	1	16	1	2	11	13.	10.	5.	5.
1621	2	16	1	2	11	16.	12.	6.	6.
1622	1	16	3	2	11	14.	10.	6.	4.
1623	1	18	1	2	11	16.	13.	7.	6.
1624	1	17	3	2	11	13.	10.	5.	5.
1625	1	17	2	2	11	15.	11.	7.	4.
1626	2	17	3	2	11	17.	12.	7.	5.
1627	2	16	2	3	11	11.	10.	6.	4.
1628	1	16	1	2	11	12.	8.	5.	3.
1629	1	16	3	3	11	17.	12.	7.	5.
1630	1	16	1	3	11	14.	11.	6.	5.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
1631	2	16	2	3	11	17.	13.	7.	6.
1632	2	16	3	3	11	13.	9.	5.	4.
1633	1	17	3	3	11	16.	13.	7.	6.
1634	1	18	1	2	11	13.	8.	6.	2.
1635	1	17	2	3	11	16.	13.	7.	6.
1636	2	16	3	2	11	14.	11.	6.	5.
1637	2	17	3	3	11	16.	11.	6.	5.
1638	2	18	1	1	11	16.	13.	7.	6.
1639	1	18	1	2	11	17.	13.	7.	6.
1640	1	17	1	2	11	16.	12.	6.	6.
1641	1	17	3	3	11	17.	12.	7.	5.
1642	2	16	1	3	11	16.	13.	7.	6.
1643	1	16	1	3	11	11.	8.	5.	3.
1644	1	16	2	3	11	13.	8.	4.	4.
1645	1	17	2	2	11	12.	7.	5.	2.
1646	2	17	2	3	11	18.	13.	7.	6.
1647	2	16	1	3	11	17.	12.	7.	5.
1648	2	17	2	2	11	17.	13.	7.	6.
1649	2	16	1	2	11	14.	11.	7.	4.
1650	2	17	3	2	11	16.	11.	7.	4.
1651	1	16	3	2	11	16.	11.	6.	5.
1652	1	16	1	3	11	16.	13.	7.	6.
1653	2	16	3	3	11	16.	12.	7.	5.
1654	1	16	1	3	11	18.	13.	7.	6.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
1655	2	17	1	3	11	13.	10.	5.	5.
1656	1	17	1	3	11	17.	13.	7.	6.
1657	1	16	2	2	11	13.	10.	5.	5.
1658	1	16	2	2	11	14.	10.	7.	3.
1659	1	16	1	3	11	15.	11.	6.	5.
1660	1	16	3	2	11	17.	12.	6.	6.
1661	1	17	3	2	11	14.	11.	5.	6.
1662	1	17	2	2	11	15.	11.	5.	6.
1663	1	17	1	2	11	19.	13.	7.	6.
1664	1	17	3	2	11	13.	10.	4.	6.
1665	2	17	2	2	11	17.	13.	7.	6.
1666	2	16	3	3	11	11.	7.	5.	2.
1667	2	16	2	3	11	17.	12.	6.	6.
1668	2	16	3	3	11	17.	13.	7.	6.
1669	1	18	3	2	11	18.	13.	7.	6.
1670	2	18	1	2	11	16.	13.	7.	6.
1672	2	17	1	2	11	16.	13.	7.	6.
1673	2	16	3	3	11	14.	12.	6.	6.
1674	2	17	2	3	11	16.	11.	6.	5.
1675	1	17	1	3	11	17.	13.	7.	6.
1676	1	17	3	3	11	17.	13.	7.	6.
1677	2	17	1	3	11	18.	13.	7.	6.
1678	2	17	2	3	11	18.	13.	7.	6.
1679	1	17	1	3	11	15.	11.	6.	5.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
1680	1	17	1	2	11	13.	9.	4.	5.
1681	2	17	1	2	11	14.	10.	5.	5.
1682	2	17	2	2	11	16.	13.	7.	6.
1683	2	17	1	2	11	17.	13.	7.	6.
1684	2	17	2	2	11	16.	11.	5.	6.
1685	2	16	1	3	11	15.	11.	5.	6.
1686	2	17	1	3	11	17.	12.	6.	6.
1687	1	17	2	3	11	15.	12.	7.	5.
1688	1	17	1	2	11	13.	10.	5.	5.
1689	2	17	2	2	11	12.	8.	4.	4.
1690	2	17	1	2	11	14.	12.	6.	6.
1691	1	17	1	2	11	19.	12.	7.	5.
1692	2	17	1	2	11	15.	12.	6.	6.
1693	2	16	3	2	11	16.	13.	7.	6.
1694	1	17	1	3	11	16.	13.	7.	6.
1695	2	17	1	2	11	8.	5.	3.	2.
1696	2	17	1	1	11	7.	5.	2.	3.
1697	1	17	1	2	11	17.	11.	5.	6.
1698	2	16	1	2	11	16.	12.	6.	6.
1699	2	16	3	3	11	17.	13.	7.	6.
1800	2	17	1	2	12	19.	13.	7.	6.
1801	1	17	2	3	12	14.	10.	4.	6.
1802	1	18	3	3	12	18.	13.	7.	6.
1803	2	17	3	3	12	16.	12.	6.	6.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
1804	2	17	2	2	12	14.	10.	5.	5.
1805	1	18	1	2	12	18.	13.	7.	6.
1806	1	17	3	3	12	15.	12.	6.	6.
1807	1	17	2	3	12	17.	13.	7.	6.
1808	2	17	3	3	12	15.	11.	6.	5.
1809	1	17	1	2	12	16.	12.	7.	5.
1810	1	17	3	3	12	17.	12.	7.	5.
1811	1	17	3	3	12	16.	12.	7.	5.
1812	1	18	3	2	12	17.	13.	7.	6.
1813	1	18	3	3	12	18.	13.	7.	6.
1814	2	17	2	2	12	15.	11.	5.	6.
1815	1	17	2	2	12	16.	12.	7.	5.
1816	2	19	2	2	12	18.	13.	7.	6.
1817	2	18	1	2	12	11.	8.	4.	4.
1818	1	18	1	2	12	18.	13.	7.	6.
1819	1	17	1	3	12	15.	12.	6.	6.
1820	1	18	3	2	12	17.	13.	7.	6.
1821	1	17	2	3	12	14.	12.	6.	6.
1822	2	17	1	3	12	14.	11.	6.	5.
1823	2	17	1	2	12	14.	11.	6.	5.
1824	2	17	1	3	12	18.	13.	7.	6.
1826	2	18	1	2	12	17.	13.	7.	6.
1827	2	18	1	3	12	14.	12.	7.	5.
1828	1	18	1	2	12	17.	12.	7.	5.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
1829	1	17	2	1	12	17.	12.	6.	6.
1830	1	17	2	2	12	11.	7.	5.	2.
1831	1	17	1	3	12	14.	12.	6.	6.
1832	1	17	3	3	12	14.	10.	5.	5.
1833	2	18	1	2	12	18.	13.	7.	6.
1834	1	18	2	2	12	16.	13.	7.	6.
1835	1	18	1	3	12	17.	12.	7.	5.
1836	2	18	3	2	12	14.	11.	5.	6.
1837	2	17	1	3	12	16.	11.	6.	5.
1838	1	17	3	3	12	19.	13.	7.	6.
1839	1	18	1	2	12	18.	13.	7.	6.
1840	1	17	2	3	12	18.	13.	7.	6.
1841	1	17	1	2	12	12.	9.	6.	3.
1842	2	18	1	2	12	17.	13.	7.	6.
1843	2	18	1	2	12	8.	4.	3.	1.
1844	2	18	2	2	12	16.	12.	6.	6.
1845	2	18	2	2	12	15.	11.	5.	6.
1846	2	17	1	3	12	18.	13.	7.	6.
1847	1	18	3	2	12	13.	10.	5.	5.
1848	2	17	3	2	12	16.	11.	5.	6.
1849	2	18	1	2	12	8.	6.	3.	3.
1850	2	17	3	3	12	15.	12.	6.	6.
1851	1	17	3	3	12	16.	12.	6.	6.
1852	1	17	1	3	12	17.	13.	7.	6.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
1853	1	17	1	2	12	15.	12.	7.	5.
1854	1	18	1	2	12	17.	13.	7.	6.
1855	1	17	3	3	12	16.	11.	6.	5.
1856	1	18	1	3	12	18.	12.	7.	5.
1857	1	17	1	3	12	14.	11.	7.	4.
1858	2	17	1	3	12	16.	12.	7.	5.
1859	2	17	2	3	12	15.	12.	7.	5.
1860	2	18	2	2	12	17.	12.	7.	5.
1861	2	17	2	2	12	16.	11.	5.	6.
1862	1	17	2	3	12	18.	13.	7.	6.
1863	2	18	3	2	12	16.	12.	6.	6.
1864	1	18	1	3	12	19.	13.	7.	6.
1865	2	18	2	2	12	13.	10.	5.	5.
1866	1	17	1	2	12	9.	6.	5.	1.
1867	2	18	1	3	12	14.	11.	6.	5.
1868	2	17	2	3	12	17.	12.	7.	5.
1869	2	17	1	2	12	14.	11.	5.	6.
1870	2	17	3	2	12	15.	11.	5.	6.
1871	2	18	3	2	12	16.	13.	7.	6.
1872	1	18	1	2	12	16.	12.	6.	6.
1873	1	17	3	2	12	14.	10.	6.	4.
1874	1	18	3	2	12	16.	13.	7.	6.
1875	1	18	3	2	12	12.	9.	6.	3.
1876	2	18	1	2	12	12.	7.	3.	4.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
1877	2	18	1	3	12	10.	8.	3.	5.
1878	2	18	1	2	12	15.	10.	6.	4.
1879	2	18	1	2	12	15.	10.	4.	6.
1880	2	17	1	2	12	13.	9.	4.	5.
1881	2	18	1	3	12	14.	11.	6.	5.
1882	1	18	3	3	12	15.	11.	6.	5.
1883	1	19	1	1	12	14.	11.	6.	5.
1884	1	17	1	2	12	18.	13.	7.	6.
1885	2	18	2	2	12	16.	12.	7.	5.
1886	2	17	2	3	12	16.	11.	6.	5.
1887	2	17	2	2	12	16.	13.	7.	6.
1888	1	17	2	3	12	15.	12.	6.	6.
1889	2	17	3	3	12	13.	10.	4.	6.
1890	2	18	1	2	12	11.	9.	4.	5.
1891	1	18	2	3	12	17.	13.	7.	6.
1892	2	18	2	2	12	9.	7.	2.	5.
1893	2	17	3	2	12	13.	10.	4.	6.
1894	2	17	2	2	12	14.	10.	5.	5.
1895	1	17	1	2	12	18.	13.	7.	6.
1896	1	17	1	3	12	18.	12.	7.	5.
1897	1	17	1	2	12	13.	9.	5.	4.
1898	2	17	1	3	12	16.	12.	7.	5.
1899	2	18	3	3	12	13.	11.	7.	4.
1900	2	17	1	3	12	15.	12.	7.	5.

ID	SEX	AGE	SES	IQ	GRADE	ORIG.	CORR.	ODD	EVEN
1901	2	17	1	2	12	15.	12.	6.	6.
1902	1	18	2	3	12	16.	13.	7.	6.
1903	1	18	1	3	12	17.	11.	6.	5.
1904	2	17	1	3	12	13.	9.	4.	5.
1905	1	18	1	3	12	16.	13.	7.	6.
1906	1	17	2	2	12	17.	12.	6.	6.
1907	2	17	1	3	12	15.	13.	7.	6.
1908	2	18	1	3	12	12.	9.	5.	4.
1909	2	17	1	3	12	17.	13.	7.	6.
1910	2	17	1	3	12	15.	11.	5.	6.
1911	2	17	1	3	12	12.	9.	3.	6.

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BIOGRAPHICAL SKETCH

William Paul Palow was born December 23, 1940, at North Miami Beach, Florida, In June, 1959, he was graduated from Hialeah High School. In April, 1963, he received the degree of Bachelor of Science with a major in mathematics from the University of Florida. He received the Master of Education degree from the University of Florida in December, 1964. While pursuing the masters degree, he was employed by the University in the capacity of resident assistant.

From August, 1965, he served as a mathematics teacher at Miami Springs Senior High School in Dade County, Florida. From June, 1966, until August, 1968, he was a full-time doctoral student at the University of Florida. During this time he worked as a graduate assistant. His duties consisted of the teaching of mathematics courses off campus through the Division of Continuing Education, Arts and Sciences. From September, 1968, unitl the present, he was employed by the University of Florida in the joint capacity of Instructor of Education and Instructor of Mathematics for the Department of Secondary Education and the Division of Continuing Education, Arts and Sciences, respectively.

Membership is held in Phi Delta Kappa and The National Council of Teachers of Mathematics.

This dissertation was prepared under the direction of the co-chairman of the candidate's supervisory committee and has been approved by all members of that committee. It was submitted to the Dean of the College of Education and to the Graduate Council, and was approved as partial fulfillment of the requirements for the degree Doctor of Education.

June, 1969

B Short by MC Baker
Dean, College of Education

Dean, Graduate School

Supervisory Committee:

Kenneth P Kidd
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